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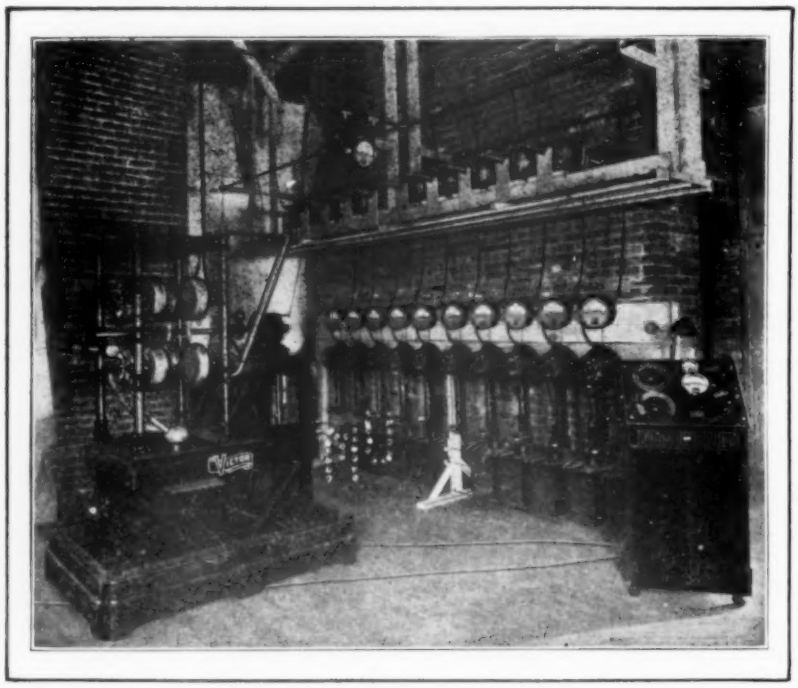

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Dental Roentgenography Shadow Values*

WILLIAM A. LAURIE, M. D.
New Orleans.

Classification of Shadows

DENTAL roentgenographic interpretation is distinctly different from the interpretation of roentgenograms of the grosser parts of the body. While the shadow of bone structure and softer tissue is similar, the pathological value of each is different, because of the virulence of small areas of destruction about the dental regions.

The picturing of the dental areas is to a degree, more difficult. The possibility of duplicating results is more difficult here than in the picturing of the long bones, or the bones of any part of the body. This fact makes possible the often discussed variation in shadows of the same area, taken of the same patient by different operators.

There should be an attempt on the part of operators to standardize their technique and the various positions from which they picture the different areas, so that they may more easily familiarize themselves with the appearance through such areas under normal conditions. When there is a variation from the normal, if the picture has been taken in the adopted manner, the variation is more easily recognized.

The matter of picturing the various dental areas will be taken up more in detail in the next paper. This paper will be devoted to the classification of shadows. It is hoped that through this classification a more simple method of reading of the dental roentgenogram will develop.

Like the tissues anywhere about the body, the character of those in the mouth may be divided into soft and bony. Of interest also from a roentgenographic point of view, are the materials used for replacements of lost parts or in treatment of infections. This makes possible a classification with shadows divided into three principal headings or grades, as Grade I (soft tissue), Grade II (bone), and Grade III (foreign matter). Foreign matter refers to such matter as is not normally found in the tissues of the body, as gutta-percha points, cements, amalgam, gold and various metals and minerals of higher atomic weight and greater density than that possessed by body tissues.

In shadows of Grade I the tissue pictured is chiefly gum tissue and that portion of soft tissue and blood vessels which is to be found in the Haversian canals and alveolar process. This tissue is poor in mineral salts in comparison with the denser bone structure. This fact alters the penetrability of these two classes of tissue and in turn their roentgenographic appearance. The basis for this division in classification is their difference in appearance when pictured.

In connection with the interpretation of the roentgenograms, the study of the tables of atomic weights and density of elements is interesting and helpful. Two comprehensive tables of atomic weights and density were published in the Service Suggestions of the Victor X-Ray Corporation, August, 1921. By their study the difference in possible penetration through various tissues as well as elements or even compound structures is made clear.

In Grade I shadows (the soft tissue being without mineral salts) such variation in this tissue as does occur is slight, so that a distinct difference in penetrability cannot be easily registered. This tissue does not picture a sharply outlined difference in shadow, in an area where it may end or begin. In the picturing of limbs and body parts there is most often a distinct line of difference between that portion of the film or plate where the outline of the part is pictured and where no interference with x-ray penetration has occurred. In the ankle one often sees an outline of the tendons, which being of greater roentgenographic resistance can be outlined, while in the calf of the leg the several muscle bellies are rarely differentiated. This difference is pictured because the ratio of penetrability difference or resistance is sufficient to register.

In the mouth the tissues of the lips and cheeks must be penetrated before gum tissue can register. These tissues are of similar density and pentrability and offer very little resistance. In most dental pictures and particularly those of the areas without teeth, a well defined area of smooth shadow character can be made out just beyond the outline of bone shadow. The difference in resistance of cheek tissue and gum tissue can often be made out on the crest of bone shadow.

Because of the slight ratio of penetration resistance in soft tissue, a pathological process is rarely pictured, when situated in soft tissue where it must be pictured through either the buccal or lingual plates of bone structure.

The greatest value in the knowledge of any pathological condition as it might be expressed in shadows of Grade I, lies in the change in its relation to bone shadow (Grade II) or as it alters the characteristic appearance of the Haversian canal formation of cancellous and alveolar bone.

For the purpose of better study, bone shadow (Grade II) as it is found about the dental areas can be divided into two grades (a and b). Shadow distinguished as alveolar or cancellous bone, to be designated as Grade II-a, while Grade II-b is the designation for denser bone structure as it is seen in the various prominences and ridges or greatly condensed in tooth structure.

Close study of a picture, bearing in mind shadow grades, will soon convince one that to represent the normal in alveolar bone (Grade II-a) there must be a proper arrangement and definite distribution of Grade I shadow within a definite, regular bone outline. This means in reality the picturing of the Haversian canals or tubules. A shadow of Grade II-a, therefore, is in reality a definite and regular mixture of shadows of the types of Grade I and Grade II-b. This is in reality the pic-

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turing of cancellous bone through a very thin plate of dense bone. Any alteration in either grade of tissue alters the size of tubules or the thickness of their walls. This changes the regular appearance and disturbs the regular relation which a shadow of Grade I bears to Grade II-b, in alveolar bone.

An acute condition which has not had time to calcify or the irritation of which has not permitted thickening of the walls of the Haversian tubules will be manifested by an increase of Grade I shadow, whereas a chronic process which has caused the cell wall thickening will have increased the density of the area, and the shadow type in the area will more greatly simulate that of Grade II-b, or the denser bone. This is an illustration of how the intimate study of the amount of each grade of shadow will reflect on the type of condition pictured.

Grade I shadow is again of importance, as it represents the peridental membrane about the roots of teeth. Normally this membrane is almost equally thick about a tooth root, except, perhaps, at its very apex. Here again any change in the extent of the line indicating peridental shadow must be made at the expense of shadow of Grade II-a, unless tooth root absorption or loss through other means, has taken place. With acuteness or chronicity of process, the amount of this shadow changes. It is through the interpretation of such change that a diagnosis of value can be made.

The root canals and pulp chambers of teeth are of soft tissue and in these spaces are always pictured through the denser bone structure of teeth. The smooth, dense or greatly resistant shadow of Grade II-b in this instance is tooth structure. The teeth in their various positions have rather definite and constant shapes, which can be easily recognized so that one group can be differentiated from another. The pulp chambers in teeth have similarly varying characteristics of size and shapes. The pulp chamber and root canals of teeth decrease the roentgenographic resistance of the teeth, through that portion of the teeth through which they extend, so that penetration through the tooth in the position of their presence varies.

As the normal cavities within a tooth bear a constant position and relation to the tooth structure, the study of the comparative position, relation and size of shadow of Grade I within Grade II-b is the interpretation of the normal or abnormal appearance of the soft tissue (pulp contents) within the tooth. The findings of a lesser density (Grade I) in an abnormal position in tooth structure, is most often decay. The position of this finding and its relation to pulp chamber shadow will indicate the position of the process. By the careful study of Grade I shadow, particularly in its position in the pulp chamber and root canals of teeth, it will be found that there is always a softness in the outline of these cavities. In such conditions as produce a putrid pulp or even an old chronic congestion of the pulp it will be found that this outline is sharper than under normal conditions. This is a matter of contrast, and careful comparison.

Grade II-b shadow is greater in mass than is the bone appearance in the alveolar shadow of Grade II-a. This is because of the greater compactness of the tissues and structures forming this grade of shadow, as tooth structure and denser bone. In a later paper more will be told of this shadow and its normal position.

Shadow of the type of Grade III is the shadow of foreign matter and masses. These masses are usually of compositions, elements, salts or metals of greater density than normal bone or tissue. They cause more obstruction to x-ray penetration than normal tissues and a greater resistance and lesser penetration. Because of the close application of a dental film to the tissues being pictured, detail is easily brought out. This sharpness of outline is readily seen in most foreign masses pictured in the dental areas.

Through the study of the dental films as representing different grades of light penetration, and by the placing of a value on the several grades of shadow, the interpretation of the picture is simplified. The essential, however, is to know where any given grade of shadow exists normally and its normal extent. This will, therefore, be the subject of the next paper. In it the subject of picturing of the several dental areas and what important anatomical landmarks may be seen in each will be taken up.

The illustration (Fig. 1) will serve to explain the three groups of shadow. Unfortunately reprints are positive prints and where greater pentration has taken place on the film, the print shows a lighter impression. The darkest parts in this picture, therefore, are indicative of the greatest resistant areas.

Grade I shadow, which interests us in the representation of the gum surface or gingiva, can be distinctly made out between the bicuspid tooth to the left of the picture and the portion of the molar to be seen in the upper right. This shadow can be seen just below the pictured alveolar process. It parallels the border of bone to a thickness of about one-sixteenth of an inch. In the original film a similar shadow could be seen between the bicuspid and cuspid tooth to the left in the picture. One can note that there is very little opportunity to recognize a difference in any degree of penetrability that may exist in a shadow of this degree, for the ratio of such a difference is not sufficient to be pictured or recognized.

The balance of the picture, except for the pictured root canal filling is entirely Grade II shadow. That portion representing alveolar tissue, where there is a generous and regularly placed amount of soft tissue shadow in its formation is classed as Grade II-a, or alveolar bone, while the teeth and such heavier lines, indicating a greater resistance as the floor of the antrum, are classed as Grade II-b. Grade I shadow is visible in the pulp chamber and part of the root canal of the bicuspid tooth. (This was explained above). In the cuspid tooth the pulp contents have been removed and that cavity filled with a foreign material of greater density and roentgenographic resistance than bone. This foreign matter forms Grade III shadow.

Note—A dental questionnaire is proposed in connection with Dr. Lurie's articles. Mail questions to the Radiological Pub. Co., 121 S. 33rd St., Omaha.—*Editor.*

Benign Bone Cysts (Ostitis Fibrosa)-Acetabular Cavity Upper End of the Femur, Trochanters, Neck or Head.

JOSEPH COLT BLOODGOOD, M.D.,
Baltimore.

IN MY LAST PAPER in this Journal, in the discussion of the crushing of the bone shell in operations for bone cysts, I reported with illustrations two cases in which the cysts involved the upper end of the femur.

In view of a recent case which has just come under observation in which the cyst involves the lesser trochanter of the upper end of the femur, and as a sequence to the previous article, I will describe, with illustrations, examples of bone cysts in the acetabular cavity and the upper end of the femur which have come under my observation.

When I made my first report in 1910[1] I had no example of the cysts in this locality. In 1920[2] there were so few that only one was mentioned.

In proportion as the public are educated to seek advice early for pain, swelling, or limp without fracture, and as x-rays are taken, more of these cysts are being revealed.

Benign Bone Cysts of the Acetabular Cavity

Case 1—(Pathol. No. 28186—Figs. 1 and 2): Benign bone cyst of acetabular cavity, first observed May 27, 1921; treatment, no operation, rest six months in bed; later crutches; now, December, 1923, two years well.

This boy, 8½ years of age, had exhibited symptoms but four months. There was a limp observed by the parents, later the boy complained of pain in the region of the knee and hip.

At the end of two months he was examined by Dr. Barton, of Washington, D. C., and an x-ray was taken by Drs. Groover and Christie. This showed a peculiar shadow in the region of the acetabular cavity. Dr. Barton described the x-ray as showing a mass springing from the inferior margin of the acetabular cavity.

The boy continued to walk without crutches, was a little lame and complained of pain. Ten days before my examination flexion deformity began, and then he was advised to use crutches.

It is important to stop here and record that these are the symptoms associated with tuberculosis of the hip, and in the days before the x-rays the diagnosis of tuberculosis would have been made and the child would have been treated with fixation. We now know that many of our favorable results so diagnosed were not tuberculosis of the hip, and this is an example of such a case.

Examination: Stripped and lying on his back the right thigh is flexed. Extension produces pain and muscle spasm. There is slight adduction which produces apparent, but no real shortening. Any active or passive motion at the hip-joint produces pain, but not of marked degree.

The x-ray (Fig. 1) taken May 27, 1921, shows a definite cyst with a thin bone shell springing from the lower and medial side of the acetabular cavity. There is no evidence in the x-ray of a periosteal shadow and no evidence of new bone formation.

Diagnosis: Periosteal sarcoma at this age is common, although I have never observed it in the pelvis at this age. In my interpretation the x-ray excluded a periosteal lesion. The shadow is that of a central lesion of bone with an intact bone shell. As I have frequently stated before in my contributions, I have never observed a central sarcoma at this age. The common central lesion at the ages under fifteen is the benign bone cyst. There have been a few examples of the benign giant-cell tumor. A focus of tubercular osteomyelitis is possible. Chondroma and myxoma must also be considered.

The smoothness of the bone-shell shadow is against tuberculosis, but there is nothing in this x-ray picture which would allow a differentiation between the cyst, the giant-cell tumor, the chondroma and the myxoma.

Method of Treatment: After a continuous study of many years I have formulated and published[3] a method of attack to use when the x-ray shows a central lesion of bone. If the patient is under fifteen the treatment should be rest with non-interference, and if further x-ray examination shows no enlarge-

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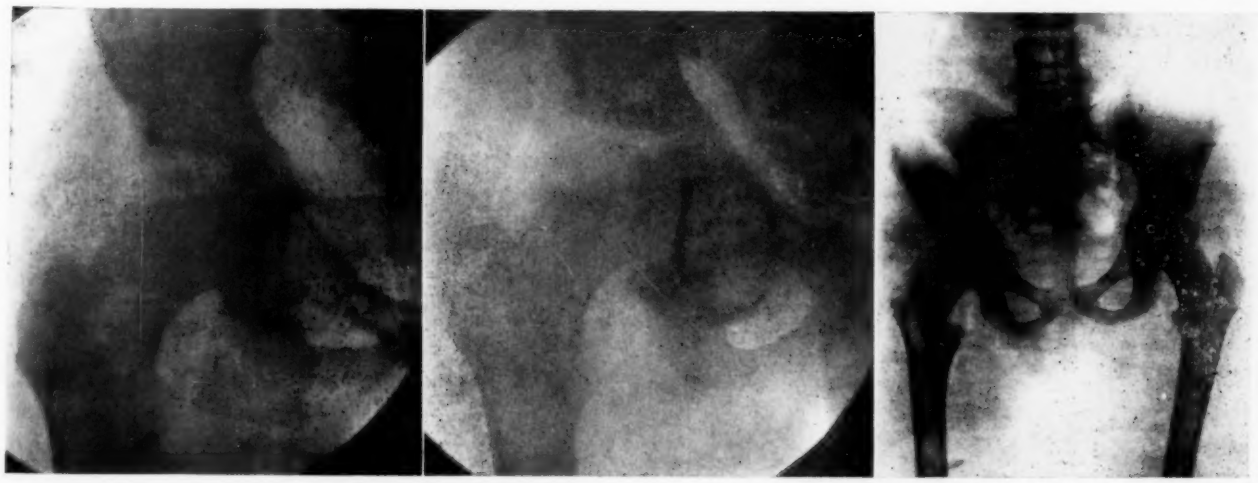

Fig. 1—Case 1—Pathol. No. 28186—Bone cyst of acetabular cavity. X-ray May 27, 1921. Patient 8½ years of age. X-ray four months after onset of symptoms.

Fig. 2—Case 1—Pathol. No. 28186—Bone cyst of acetabular cavity. X-ray September 29, 1921, four months after x-ray shown in Figure 1, eight months after onset. No operation. This x-ray shows beginning ossification.

Fig. 3—Case 2—Pathol. No. 29108—Bone cyst of lesser trochanter. X-ray October, 1921, six months after onset. The cystic area has almost completely ossified. Patient aged 10 years.

ment and ossification of the cavity, one can be quite certain that the lesion is either ostitis fibrosa or tuberculosis. However, when x-ray examination shows the cyst enlarging, nothing is to be gained by delay.

Treatment in This Case: All other examinations were negative. The child was sent home and put to bed, absolutely at rest, and as much as possible in the sunshine.

Second Examination in Three Weeks: Adduction and apparent shortening have disappeared; muscle spasm is less; flexion deformity less. X-ray picture shows no changes.

Third Examination in Five Weeks: The boy has now been in bed five weeks; flexion deformity has disappeared. There is very slight muscle spasm on abduction and adduction. X-ray shows undoubted beginning ossification.

About two weeks later the boy was allowed to get about on crutches.

Examination September 19, 1921, Four Months: The x-ray (Fig. 2) as compared with Figure 1 shows almost complete ossification of the cyst. The boy is clinically well. There is no pain, no muscle spasm. Dr. Barton writes: "The boy is so well that he wants to walk without crutches." Within a few weeks the boy was allowed to gradually give up his crutches, and up to the present time, December, 1923, there has been no recurrence of the symptoms.

Remarks: Why should rest in this case be associated with an almost immediate disappearance of the pain, the deformity and the muscle spasm and the apparent healing of the cyst in the x-ray picture? We do not know. But it would seem reasonable in any individual with pain, limp and muscle spasm of a joint to at least begin treatment by rest.

We have ample evidence that the bone cyst heals spontaneously, but in the early years we only saw the cyst with a fracture, or the cyst not healing, but expanding. Now we are observing an increasing number of smaller cysts without fracture, and in this stage one cannot tell, except by observation under x-ray control whether ossification will take place without fracture or operative methods. But when the patient is under fifteen, nothing is lost by non-interference and rest. If the child is anemic or under-weight this should receive appropriate treatment. If there are foci of infection in teeth or naso-pharynx, they should be removed. But in the majority of cases these patients have been otherwise apparently healthy.

It is very important to constantly bear in mind that favorable results such as obtained in this case do not always take place. The cyst may become larger and larger, bending deformity may develop, producing a local condition difficult to remedy. Therefore, there should be no delay if the x-rays show that the cyst is enlarging or not ossifying. The more fortunate thing that may happen is a fracture, and as a rule after this the cyst heals.

Fig. 4—Case 2—Pathol. No. 29108—Bone cyst of lesser trochanter. X-ray June 12, 1922, eight months after x-ray shown in Figure 3. Area of cyst practically ossified. The child is clinically well.

Fig. 5—Case 2—Pathol. No. 29108—Normal side of case shown in Figures 3 and 4. This x-ray should be used in comparison with the others as normal for a child 10 years of age.

CYSTS OF THE LESSER TROCHANTER

CASE 2—(Pathol. No. 29108)—Cyst of the lesser trochanter in a child aged 10 years; treatment, rest and fixation. Well December, 1923, almost two and one-half years.

I saw the x-ray in this case with Dr. Karl Snyder in October, 1921 (Fig. 3). The patient was then wearing a brace. The symptoms of onset were rather unusual. The father, a physician, observed an increasing curvature of the spine (no limp or pain); then a dragging of the foot; then apparent shortening. It is stated that there was no pain or muscle spasm. General health good.

When the x-ray was taken, about October, 1921 (Fig. 3) it showed a distinct lesion of the lesser trochanter and the shaft beneath it. The trochanter is a little larger and beneath it there is evidently the remains of a small bone cyst which has almost completely ossified. A correct diagnosis of ostitis fibrosa has been made.

Result May, 1922: Dr. Snyder writes that the child has been in a Thomas' ambulatory splint for one year; there is no pain, no deformity. There is slight apparent shortening.

X-Ray June, 1922: (Fig. 4, affected side and Fig. 5 normal side). Figure 4 was taken eight months after Figure 3. The ossification is not yet perfect, but it suggests a healed lesion. It is a better plate than Figure 3. When we compare it with Figure 5 we observe that a cortical bone below the trochanter has disappeared and is replaced by irregular ossification. Observe the arch of new bone formation passing up into the neck. From the last report the patient is well and walking without fixation.

CASE 3—(Pathol. No. 33120)—Cyst of the lesser trochanter of very recent origin (see Figs. 6, 7, 8) found in a child of 9 years. Symptoms two weeks.

This boy, aged 9 years, was examined in my office today, June 1, 1923. Stripped and lying on his back there is no apparent deformity, there is no shortening and no muscle spasm. One would be unable from this examination to tell which limb is affected. Two weeks ago his enlightened teacher observed that the child limped, reported this to the parents, and an x-ray was taken. The patient has no pain and did not know of the limp until informed by his teacher. There have been various interpretations of this

x-ray, from sarcoma to a benign bone cyst. The x-ray impresses me as a picture which Case 2 would have shown in an early x-ray. The area of bone destruction is in the lesser trochanter and in the shaft beneath.

Figures 6, 7 and 8 are x-rays taken by Dr. Kahn in my office May 30, 1923. In Figure 6 we see chiefly an expansion in the region of the lesser trochanter, with some cystic areas. In Figure 7, taken from another view, we see that the expanded area is very cystic, extending into the marrow of the shaft. In Figure 8, another view, we observe that the marrow cavity is involved. In all three x-rays the bone shell is intact.

This case shows the importance of taking more than one view. In Chicago x-rays were taken of almost the entire skeleton—no other cysts could be seen. The x-ray of the chest by Dr. Kahn is negative. All other examinations are negative.

Treatment Suggested: The treatment followed in Case No. 1 was advised—rest in bed, forced milk and cream diet with plenty of green and cooked vegetables; then crutches and a Thomas splint, then crutches; x-rays to be taken once a month. If the cyst enlarges or shows no ossification, operate, first, to establish the diagnosis; if it proves to be the giant-cell tumor, chondroma or myxoma, remove the involved area with the cautery; if it is a benign cyst, crush the cyst wall after curetting out the connective tissue lining if present.

Cysts of the Head and Neck of the Femur

Case 4—(Pathol. No. 30359)—Figure 9 shows a cyst of the upper end of the femur involving the neck with slight coxa deformity of at least twenty years' duration. This patient was referred to me by Dr. James F. Mitchell of Washington, D. C., in May, 1922, when an x-ray had been taken because of a chronic arthritis.

The x-ray (Fig. 9) shows a definite cystic shadow in the upper half of the neck and head. Surrounding it there is a distinct zone of new bone formation. The cyst shows partial ossification. The head appears somewhat like a mushroom on the neck, there is shortening between the lesser trochanter and the acetabular ring like a coxa vara. The patient remembers that at the age of 30, twenty years ago, stiffness and pain were experienced in the right hip after playing baseball and taking a cold shower. These attacks recurred after the same factors for several years. Twelve years ago there was an acute attack after a long hot motor ride and a plunge in the cool ocean. The intense pain lasted eighteen hours, and the patient was unable to walk. About five years ago there was another acute attack after sitting in a cramped position in a theater. He was unable to walk for some hours. Recently he has had discomfort most of the time. Exercise increases the pain. He limps, yet he walks without crutches or pain even on long tramps. One year ago he had his tonsils removed. He has been treated for pyorrhea. The x-ray was taken but recently by Dr. Groover of Washington.

The symptoms in this case are very much like those I reported in the Journal of Radiology for August, 1922,[1] The x-ray picture (Fig. 6) and history in this case suggested an ossifying periostitis due to gonorrhea. This patient is well (December, 1923) two years and three months since first observed.

Remarks: The x-ray and history suggest a partially healed bone cyst of many years' duration, perhaps dating back to childhood. In the early stages of the cyst there was bending deformity

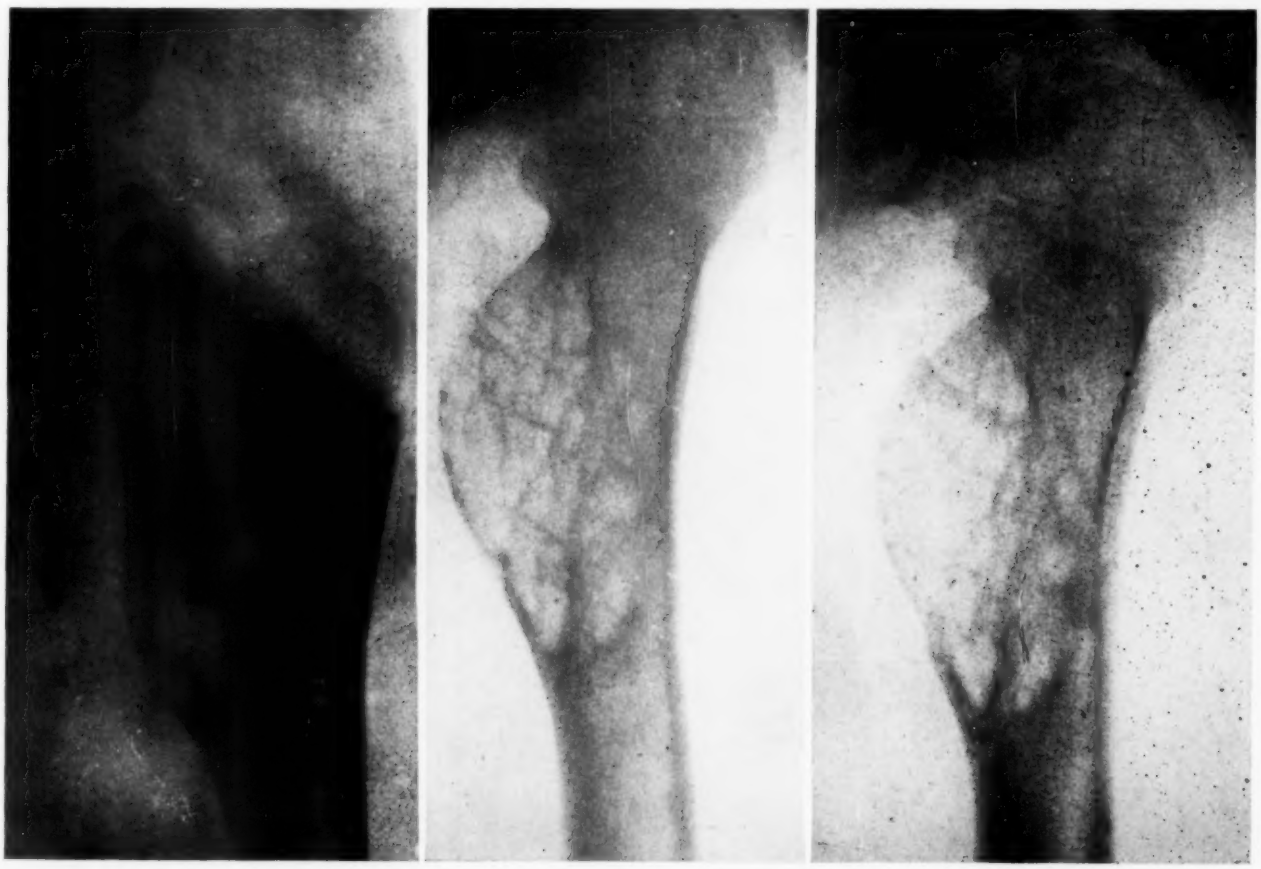

Fig. 6—Case 3—Pathol. No. 33120—Benign bone cyst of lesser trochanter with involvement of the shaft beneath. X-ray two weeks after first symptom. See Figures 7 and 8 for other views.
Fig. 7—Case 3—Pathol. No. 33120—Benign bone cyst of the lesser trochanter. X-ray two weeks after onset of symptoms in a child aged 9 years. Compare with Figures 6 and 8.
Fig. 8—Case 3—Pathol. No. 33120—Benign bone cyst of lesser trochanter. X-ray two weeks after onset of symptoms in a child aged nine years. Compare with Figures 6 and 7.

producing coxa vara, and this was followed by secondary slight arthritis, and all of his chronic and acute attacks belong to the type of snapping hip. I expressed the opinion to Dr. Mitchell that operation was not indicated in this case unless the symptoms grew worse, or the x-rays showed further changes.

Cysts of the Neck of the Femur: In the previous paper, in one case (Pathol. No. 32339) the cyst involved the neck and the region of the great trochanter, it was of fourteen years' duration and there was beginning bending deformity. This bending deformity could have been prevented by an earlier operation. In the second case (Pathol. No. 32199) the cyst when first observed in April, 1921, involved the region of the great trochanter and extended into the neck of the femur; it had been allowed to greatly enlarge under x-ray observation. Although operation has been advised, there is no report.

CASE 5—(Pathol. No. 30840)—(Fig. 11): Cyst of the neck of the femur. Adult, aged 25.

These x-rays were sent to me in July, 1922, by Drs. Gaenslen and Schumm of Milwaukee, Wisconsin. Fig. 10 is the x-ray taken November 8, 1921, and Fig. 11, April 12, 1922. There is five months' interval between the x-rays. The shadows of the cyst in the neck show few changes. Both suggest a healing cyst. The light area of the cyst is surrounded by a narrow zone of dense bone. The cyst extends from the head of the femur to the intertrochanteric line.. Dr. Schumm who made the x-rays was of the opinion that there is also a cyst in the upper end of the shaft of the femur. I am not certain of this. Unfortunately, the x-ray extended no further than shown in the illumination. In my note made in September, 1922, I felt certain of the healing cyst in the neck of the femur.

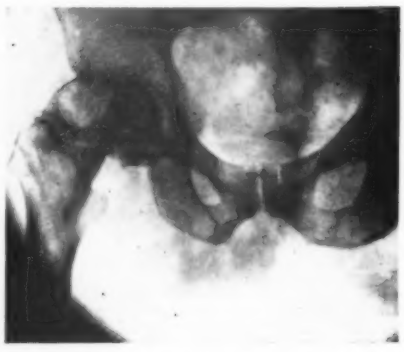

Fig. 9—Case 4—Pathol. No. 30359—Benign bone cyst of head and neck of femur. X-ray taken twenty years after first symptoms. Patient aged 50 years. Note the deformity of coxa vara and the slight arthritis.

Onset: In July, 1918, three years before the first x-ray was taken, the patient fell on his hip. There was pain and some functional disability for a few weeks. The pain then practically disappeared, but would return. The pain is worse in damp, cold weather. It is experienced when he twists the hip. The patient is more comfortable when lying down. There is no limp. The x-ray was taken three years after the injury because of pain. At this time there was no limp, no measured shortentng, but there is pain and limitation of abduction, rotation out; tenderness on pressure over the upper third of the femur.

I made very careful examination of the original x-rays comparing right with left, and there was no measured shortening, no coxa vara.

Treatment: In view of the evidence of healing and not marked symptoms I advised against operation.

Operation: Apparently an exploratory operation was done, because tissues were sent to the laboratory which show the picture of ostitis fibrosa.

Further Report: The patient's age is now given, 25, so he was 21 at the onset. In February, 1923, there was no marked change, still pain.

Remarks: The close relation of this cyst to the trauma might suggest trauma as an etiological factor in these cysts, but when we go over a large number of cases this evidence is present in a very small number. We now know that these cysts may develop and give no sign of their presence until an injury, fracture, contusion or sprain, leads to an x-ray and reveals their presence. We know that these cysts may remain partially or completely unhealed for years.

In this case a contusion of the hip-joint could have produced his symptoms even if there had been no cyst.

CYSTS IN THE REGION OF THE GREAT TROCHANTER

CASE 6—(Pathol. No. 17871)—Cyst in the region of the great trochanter. Operation. Recovery.

This case has previously been reported in the Journal of Radiology for March, 1920 (Fig. 2).

Clinical Note: The patient was a white female aged 23; there had been localized pain in the trochanter for six years, that is, since the age of 17. A pathological fracture was acquired after a slight trauma ten weeks ago. The x-ray before operation shows a distinct bone shell, the base of the cyst is the intertrochanteric line. There is no periosteal bone formation from the outer shell. Only the age of onset suggests a cyst. A giant-cell tumor, a chondroma, myxoma or early sarcoma might produce such an x-ray picture.

The operation was done by Dr. Prince of Rochester in 1915. The involved trochanter was chiseled off. The gross specimen is typical of a bone cyst—a thin bone shell, a thick, leathery connective-tissue lining, and a central cavity containing clear fluid.

The gross appearance resembles Figure 25 in the *Journal of Radiology* for March, 1920, Pathol. No. 19179. This case is of especial interest because at that time, now only three years ago, it was diagnosed spindle-cell sarcoma and the leg amputated. On restudy I changed the diagnosis to ostitis fibrosa. The patient is well in 1923, seven years after amputation of the femur.

I emphasize this mistake here because in a number of instances benign bone

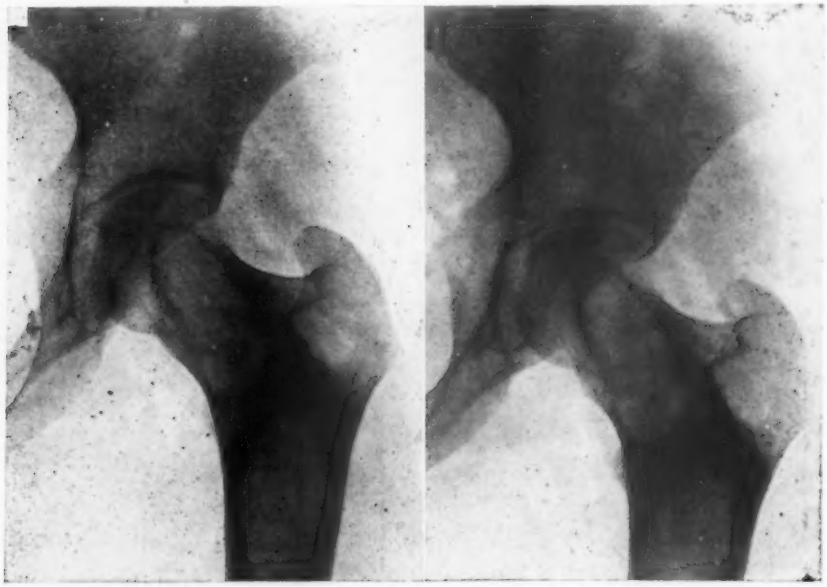

Fig. 10—Case 5—Pathol. No. 30840—Benign bone cyst of neck of femur. X-ray November 8, 1921. Male, aged 25. Duration of symptoms three years. X-ray shows some ossification of the cyst, especially of its outline.

Fig. 11—Case 5—Pathol. No. 30840—Benign bone cyst of neck of femur. X-ray April 20, 1922, five months after x-ray shown in Figure 10. No changes.

cysts have been diagnosed sarcoma and unnecessary amputations performed.

Cysts of the Great Trochanter and Upper End of the Femur

This position of the cyst and positions lower down in the shaft are much more common than in the greater and lesser trochanter, neck or head of the femur and, strangely, pathological fracture is more frequent when the cyst involves the shaft.

Case 7—(Pathol. No. 13829)—Cyst in the upper end of the femur involving the trochanter. Pathological fracture. Healing. Well nine years later (Figs. 12 and 13).

The x-rays and data were sent to me by Dr. Lovett of Boston in 1912. The child, a white female, aged 7 years, had walked with a limp for seven months. For six weeks the limp has been worse and the child has been complaining of pain. Two days before admission to the hospital the child fell and has been unable to walk since. There has been pain and tenderness in the region of the upper end of the femur.

Examination: The left leg is abducted and rotated outwards; there is swelling in the upper third of the femur. A diagnosis of fracture was made, and the patient was put up in Buck's extension. Some days later the x-ray (Fig. 12) was taken. It shows the bone cyst, the fracture and a piece of the bony cyst wall projecting medially. Both trochanters seem involved; the neck and the head are normal. The fracture is in good position.

Figure 13 is an x-ray some months later. Note the new periosteal bone formation, on the outer side more marked than on the inner. The projecting portion of the bone cyst in Figure 12 is not seen in Figure 13—either it has been absorbed or the x-ray was taken from a different position and it is not shown. The fracture has healed in good position. The bone cyst is not yet completely ossified. In 1921, nine years later, Dr. Lovett writes that the child is well and walks without a limp, but he has been unable to get an x-ray since.

Case 8—(Pathol. No. 17171)—Cyst in the upper end of the femur and trochanter. Operation 1913. Well, with x-ray (Fig. 14) 1920, seven years.

This case is reported, because we have an x-ray taken seven years after the pathological fracture and curetting, and although the patient is clinically well, the x-ray of the upper end of the femur, trochanter head and neck shows definite changes from normal. In Figure 14, in the region of the trochanter there are still light areas, due to remaining cysts or fibrous tissue. The fracture has healed with a coxa vara deformity, and there is bone more dense than normal in the head, neck and intertrochanteric line, probably due to the line of weight bearing.

This case illustrates that a fracture in a bone cyst may be more difficult to restore to normal than an ordinary fracture. Nevertheless the anatomical result has been by no means perfect and may later in life give rise to trouble, as in Case 4, illustrated in Figure 8.

Sections of this Case 8 were sent to me in 1914 by Dr. Hubbard of Boston, and a later x-ray by Dr. George, who writes in October, 1920, that he has a full set of x-ray pictures of this case operated on by Dr. Hubbard. The x-ray was taken because of a deformity due to fracture, and at the same time a cyst was found. At that time, 1912, there was a discussion between Drs. George and Hubbard whether the lesion should be treated as an ordinary fracture and reduced, or whether the cyst should be explored and its pathology ascertained. Judging from Dr. Hubbard's letter, one gets the impression that it was explored for diagnostic purposes, and the fracture was not reduced. This may explain the slight deformity. Dr. Hubbard writes that his pathologist diagnosed it osteosarcoma. My report made the diagnosis of ostitis fibrosa with some giant cells.

When the patient came under Dr. Hubbard's observation he was 18 years of age and had sustained a spontaneous fracture in the upper end of the femur. The original x-ray I have not seen.

This case, therefore, illustrates that in 1912 a benign bone lesion was diagnosed, microscopically, sarcoma. Apparently Dr. Hubbard acted upon the other diagnosis of a benign lesion.

Result in 1920: The patient complains of no pain. There is shortening, but the slight limp is corrected by a high shoe. There is some limitation of motion in the hip joint.

Microscopic Study: Figure 15 shows an area of ostitis fibrosa containing giant cells of the epulis type. From this picture one can see how easily a diagnosis of giant-cell tumor could be made, which would lead to a much more extensive curetting. Figure 16 is a more typical area of ostitis fibrosa; to the left the more cellular portion with here and there a blood vessel, to the right the more fibrous portion.

Case 9—(Pathol. No. 28913)—Unrecognized bone cyst of upper end of femur involving trochanter and neck. Curetting. Diagnosed spindle-cell sarcoma. Removal of upper end of femur with head. Bone grafting. Later removal of graft. Present result—two years, "fair; can walk without crutches."

This case is reported because the patient was an adult, the clinical picture was misinterpreted, and the first microscopic diagnosis was incorrect. In my opinion, if the correct diagnosis had been made, there would have been less operating and a better result.

Clinical Note: The patient was a white female, aged 23, and had had a limp most of her life. In the sixth month of pregnancy, three years ago, she observed pain in the hip for the first time; this grew worse and she was forced to use a crutch. The clinical impression was sacro-iliac subluxation with some restriction of motion in the left hip joint.

Examination Under Ether—April 22nd, without x-ray—During this examination a fracture was produced. Then an x-ray was taken, which was interpreted as a pathological fracture with bone destruction due to sarcoma.

Fig. 12—Case 7—Pathol. No. 13829—Cyst in the upper end of the femur involving the trochanter. Pathological fracture. Fracture treatment. The x-ray of a child aged 7 years was taken ten days after reduction and extension of the fracture. For result see Figure 14.

Fig. 13—Case 7—Pathol. No. 13829—Cyst in the upper end of femur involving the trochanter. Pathological fracture. X-ray taken some months after that shown in Figure 13. Patient aged 7. Now (May, 1923) well nine years after fracture.

Second Operation—April 26, 1921—At this operation a soft, cellular tumor mass was found in the capsule of the hip joint. Frozen sections were diagnosed spindle-cell sarcoma. Later, I was informed, that the tumor was within a shell of bone. After this frozen section the tumor involving the head, neck and trochanter, was removed. Then there were four treatments with radium.

Third Operation—September 11, 1921—About four and one-half months later. On account of persisting sinus the bone graft was removed.

Microscopic Study: The tissues from these two operations were referred to my laboratory. The soft tissue of the first operation showed ostitis fibrosa with evidence of new bone formation, the tissue from the second operation was granulation tissue.

Result May, 1923: Her physician writes that the patient is walking with crutches, but can walk some without them. She is able to perform her duties as a teacher, and she is relieved of pain.

We must look upon this as a good result after resection of the upper end of the femur.

Remarks: The clinical picture is that of an old affair dating from before ten years of age, and probably in the beginning not unlike cases in Figures 8 and 9. If an x-ray had been taken before the manipulations the fracture would not have been produced, and the misinterpretation of the x-ray and the frozen section led to an unnecessary operation. I do not report this case to criticise it, but simply to show that bone cystst of the upper end of the femur, especially when seen in adult life, present difficulties in diagnosis, and that good pathologists mistake ostitis fibrosa for sarcoma.

Had this patient been x-rayed before her pathological fracture, one could have said: If this is sarcoma it is hopeless from the standpoint of operation; there is not a single case of sarcoma of the upper end of the femur cured by amputation. Therefore, one could have explored to ascertain the nature of the pathological fracture, chiefly to curet a giant-cell tumor, if present. If the giant-cell tumor was not present and it was not a chondroma or myxoma, it should have been treated on the diagnosis of a bone cyst and a fracture produced to insure the best healing in the best position. If chondroma, myxoma, or a giant-cell tumor was revealed, the tissue should have been removed with the electric cautery, and with the remaining fragments of bone the best restitution to normal should have been attempted.

If the case had been seen after the pathological fracture, operation was not indicated. It would not cure the sarcoma, and for the other lesions it is best to wait and observe whether healing takes place. During this time there would be no objection to giving x-ray or radium treatment. If complete ossificaion and restored function did not take place, operation would be indicated with the same method of attack as previously outlined if there had been no fracture.

It is to be remembered that these methods of diagnosis and methods of attack have been repeatedly discussed in my previous articles in this Journal and in other contributions. They are based upon the known results of different methods of treatment, of known pathological types. They are based upon facts and not upon theories, and they are modified as experience teaches, and will be again and again discussed in future papers, with the evidence. The writer will welcome any evidence for or against his methods of diagnosis or of treatment. He will especially welcome evidence against these methods.

Conclusions: I have reported here all the cases of benign bone cysts of the upper end of the femur of which I have good records. I have omitted a few in which the cysts extended well down into the shaft, because they belong to the region and problem of the upper third of the shaft of the femur.

Up to the present time I have not a single record of a proved central sarcoma of the upper end of the femur. Periosteal sarcoma has been observed here in adults and younger individuals. None have been cured by hip-joint amputation.

Giant-cell Tumor: One example, Dr. McClure of the Ford Hospital in Detroit has sent me the records, x-ray and tissues of a giant-cell tumor of the upper end of the femur. He resected the head, neck, trochanter and a portion of the upper third of the shaft and transplanted into the defect a piece of the upper end of the fibula including its head. I saw this patient at a clinic in Detroit some time ago; she was walking well on crutches and she could walk some without them. I am not quite certain whether in McClure's case there was sufficient bone shell to attempt curetting, but his case is of great interest, because it demonstrates that very good functional results can be obtained if the extent of the disease indicates resection of the upper end of the femur.

Chondroma: So far no proved case, but in one instance with multiple chondromas the one in the upper end of the humerus was excised, and in this case the x-ray showed a central shadow in

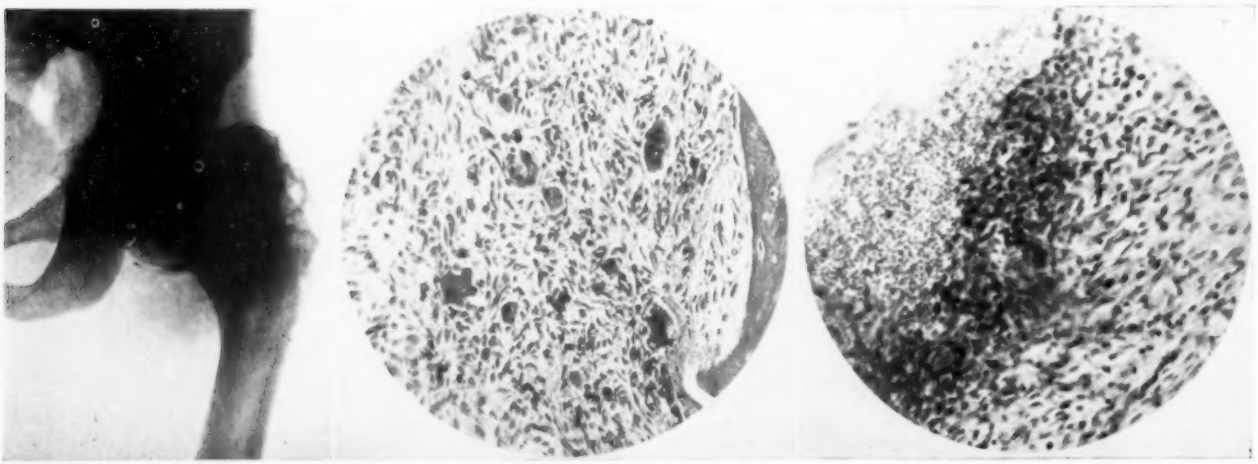

Fig. 14—Case 8—Pathol. No. 17171—Benign bone cyst in the upper end of the femur and trochanter. The x-ray was taken seven years after the fracture and curetting operation. The patient is now (May, 1923) clinically well with some shortening. The x-ray shows ossification with coxa vara deformity.
Fig. 15—Case 8—Pathol. No. 17171—Benign bone cyst in the upper end of the femur and trochanter. Photomicrograph from area in curetted tissue showing giant cells of the epulis type and ostitis fibrosa.
Fig. 16—Case 8—Pathol. No. 17171—Benign bone cyst in the upper end of the femur and trochanter. Photomicrograph of area in curetted tissue. Typical ostitis fibrosa; cellular granulation tissue to the left, more fibrous tissue to the right.

the neck of the femur which could have been chondroma and has not changed after some years' observation.

Central Myxomas have not been observed in the upper end of the femur.

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The Operation of X-Ray Tubes at High Voltage*

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I.
INTRODUCTION

During recent years there has been in x-ray therapy a trend toward the use of shorter wave lengths. It, therefore, becomes interesting to study the conditions which govern the behavior of tubes at the maximum voltage at which they may successfully be operated, to determine the life of tubes operated under the best conditions at this voltage, and to investigate means of increasing the x-ray output of tubes operated at the maximum voltages.

II.
LIFE TESTS OF UNIVERSAL TYPE HIGH-VOLTAGE TUBES

We have, for several months, been life-testing in this laboratory high-voltage tubes operating under different conditions. Two high-voltage machines have been used, but progress has been necessarily slow. Forced tests are unsafe and, to determine whether a given type of tube will have a certain life under a given set of conditions, it is necessary to actually life-test several tubes of this type under the given conditions.

All of this work has been done on the interrupterless type of machine with a four-arm rectifier.

For smooth operation of the tube, it is necessary that a considerable amount of ballast resistance should be used in the low tension circuit of the x-ray transformer.

In general, the life of the tube decreases rapidly as the voltage increases. It is then very desirable that, in operating at, say 200,000 volts, high tension surges above this point should be as effectively suppressed as possible. For this reason, sudden changes in tube milliamperage are to be avoided as they are accompanied by marked changes in the voltage impressed upon the tube terminals.

In line with the preceding paragraph, our experience goes to show that the Kearsley stabilizer is not conducive to the smooth operation of high-voltage tubes. We have been able to obtain much smoother operation by eliminating the Kearsley stabilizer and using what may be called a stabilizing connection. The apparatus change involved in the use of the stabilizing connection is so slight and the result is so good that it seems desirable to go into this matter at some length.

In Figure 1 are given two wiring diagrams showing the electrical connections from the supply line to the x-ray transformer and to the filament transformer. The diagram to the right *(A)* shows the usual system of connections in which one of the primary leads of the filament transformer is attached at a point *(a)* between the supply line and the resistance control. If this connection, instead of being made at *(a)* is made at a point *(b)* beyond the resistance control, as in diagram *(B)*, we have a system involving what we have called the stabilizing connection.

Measurements were made with the two systems to determine the relation between line voltage, voltage on the primary of the x-ray transformer, and milliamperage through the tube. These measurements were made by maintaining constant filament current and a fixed setting of the resistance control, and recording the change in milliamperage through the tube and in primary voltage, as the line voltage was varied over a wide range. The results of these measurements for each system are given by the graphs shown above the corresponding wiring diagrams in Figure 1.

It will be seen from these graphs that with the usual system *(A)*, the milliamperage increased very rapidly as the line voltage was raised, and that the primary voltage fell off rapidly. As the tube voltage runs parallel to the primary voltage this means that the tube voltage also fell off rapidly. On the other hand, with the stabilizing connection *(B)*, over a much wider range of line voltage, the change in primary voltage was much less and the primary voltage remained practically constant.

It is interesting to calculate the effect upon x-ray production of the changes in tube voltage and milliamperage which would be produced by the usual voltage fluctuations of the supply circuit. Values covering a line voltage fluctuation of five per cent, taken from the graphs in Figure 1, are given in Table I. Data given in an earlier publication[1] by Coolidge and Kearsley have been used for calculating the percentage change in x-ray intensity.

Data were not available for calculating the change in x-ray intensity which would result from the great changes in tube voltage and milliamperage present with the regular connections. It should be noted that a five per cent fluctuation in line voltage means that the voltage is varying from two and one-half per cent above to two and one-half per cent below the average value. Therefore, as indicated in the table, the x-ray intensities with the stabilizing connections and the Kearsley stabilizer would vary only seven and one-half and ten per cent respectively from the mean value.

TABLE I.

System	Percentage Change in Line Voltage	Percentage Change in Primary Voltage	Percentage Change in Milli-amperage	Percentage Change in X-ray Intensity (Under .98 mm. Copper)
Regular Connections	5	30	46	—
Stabilizing Connections	5	1	13	15
Kearsley Stabilizer	5	5	0	20

In comparison with the Kearsley stabilizer, the stabilizing connection, then, is not only conducive to smoother operation, but gives an x-ray output which is less affected by line voltage fluctuations.

A complete diagram of an x-ray machine with stabilizing connection is shown in Figure 2. The usual filament transformer and filament control may be used. In this case it is necessary to employ the small step-up transformer shown in the diagram. The x-ray switch is provided with an extra blade, which, when closed, short-circuits a resistance located in the primary circuit of the filament transformer. This resistance is necessary to avoid too high

*—Read at the Annual Meeting of the Radiological Society of North America, Detroit, Dec., 1922.

a filament current before the x-ray load is thrown on.

Preliminary tests indicated that the life of the Universal type of high voltage tube, operated at four milliamperes and 200,000 volts (max.), was several hundred hours.

At eight milliamperes the result was at first very different. Using the stabilizing connection and with the tube in the ordinary lead glass bowl, the life of three tubes was seven and one-half, nine and one-half and ten hours respectively. This was without forced air circulation. We then tried forcing air from a small Sirocco blower through the bowl around the bulb. The first tube was run for 100 hours, at the end of which time it seemed as good as at the start. The second tube had a poor vacuum and did not operate smoothly. It was run, however, for thirty hours and at the end of that time seemed neither better nor worse than at the start. These tests showed that, with as much as eight milliamperes tube life can be materially increased by the use of forced air circulation. That there can be no question about this conclusion was demonstrated repeatedly by operating with and without the Sirocco blower. Without the forced air circulation, the tube operation would become unsteady, as indicated by the fluctuating milliamperage and high voltage surges. Upon turning on the blower, the unsteadiness would disappear inside of one or two minutes. Upon stopping the blower, the unsteadiness would gradually return and would again disappear when the blower was turned on[2].

The blower used was the "Utility," made by the American Blower Company, of Detroit. This is a small device with a one-twentieth H. P. motor.

Those tubes which were operated at 8 ma. and 200,000 volts showed, after a few hours, a marked sagging of the anode stem, the bend taking place near the point of attachment of the molybdenum stem to the tungsten target. Such bending is, of course, not permissible, for, as a result of it, the focal spot might, in part, leave the working face of the target and get on to the cylindrical surface. In this case the output of x-rays in the direction of the central beam would be reduced and would no longer correspond to the milliamperage employed. To keep the target in the center of the bulb for the life tests, the tube was occasionally given a half turn about its axis.

By means of two slight structural changes it has been found possible to prevent the sagging of the anode at 8 ma. These changes will go into effect in the immediate future and to indicate that they have taken place, the tube will then be marked "8 ma."

To operate satisfactorily at 8 ma. and 200,000 volts, it is then desirable to—

(1) Use ballast resistance in the low tension circuit of the x-ray transformer.

(2) Use the stabilizing connection which has been described.

(3) Use forced air circulation around the bulb.

(4) Use tubes having more rigid support of target.

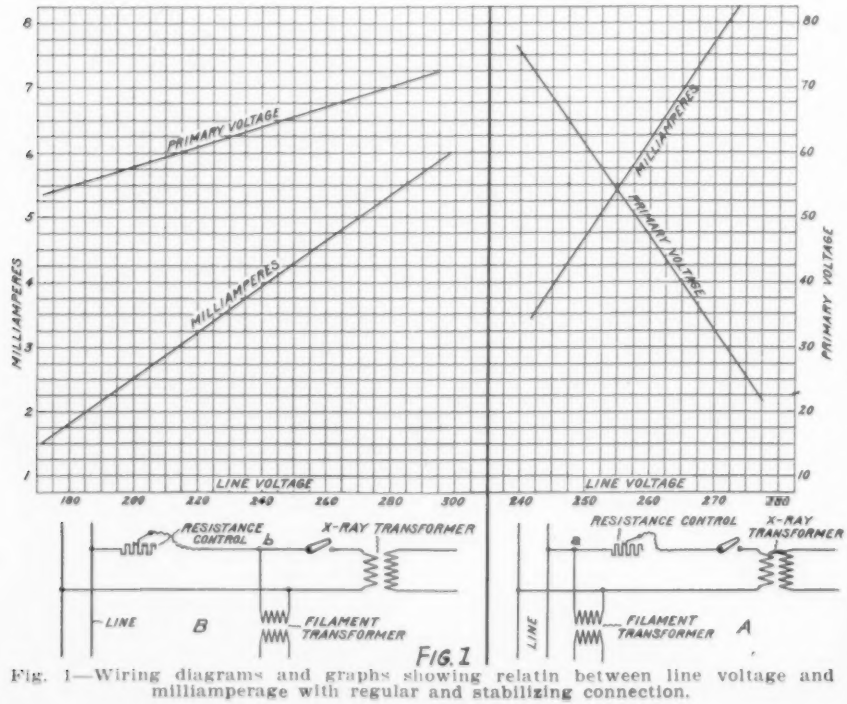

Fig. 1—Wiring diagrams and graphs showing relatin between line voltage and milliamperage with regular and stabilizing connection.

Is 8 ma. the limit? Yes, essentially so with the present tube. We have in one instance used 12 ma. at 200,000 volts for eighteen hours, but the target was so hot that it vaporized badly, giving a very heavy metallic deposit on the bulb.

III.

Oil Immersed Tube

There are two limitations standing in the way of any considerable increase in the capacity of the present tube; the target would get too hot and vaporize and the glass would get too hot and collapse.

To take care of the first of these limitations, the surface of the target can be increased. We are now experimenting with a tube similar to that shown in Figure 3, the target of which consists of a four-inch disc of tungsten. This disc has about nine times the superficial area of the target in the standard tube and is, therefore, capable of radiating about nine times as much energy. At 200,000 volts it should then handle as much as 70 ma. The focal spot is made larger by the use of a special design of cathode in which a molybdenum pin projects slightly from the center of the filament spiral.

The second limitation may be taken care of by immersing the tube in water-cooled oil. In our experimental work, the tube described above was immersed in a metal tank 15″ by 16″ by 48″ filled with transformer oil, Figure 4. The oil was cooled by tap water flowing through a system of copper tubes located close to the walls of the tank. Sufficient water was used to keep the temperature of the oil below 75°C, with the tube operating at 30 ma. and 200,000 volts.

We have just operated such a tube in this manner at 30 ma. and 200,000 volts for 40 hours. It ran very smoothly for this time and was finally broken by mechanical strain. Inspection showed, however, that this tube, even if it had not been broken, would probably not have had a much longer life, as the inner surface of the glass bulb in some places showed considerable punishment.

The life of many experimental tubes of this same general type was much shorter than that of the one just mentioned. Failure was usually due to the area of more than a square centimeter erosion on the inner surface of the glass. In one tube the glass wall of the bulb at a point near the cathode over an area of more than a square centimeter, was so strongly eroded that the bulb at this point finally collapsed under the pressure of the atmosphere. The thickness of the glass wall at this point had been reduced to only two or three thousandths of an inch.

The erosive action in these tubes was not confined solely to the glass, but some of it took place on the cathode focusing device. It seems probable that the erosive action is due to electronic or ionic bombardment. In these tubes, with such large amounts of energy, the inner surface of the glass must be at a temperature which is high compared with that of the oil. The electrical conductivity of glass rises rapidly with temperature and there may, therefore, be an appreciable electrolysis of the glass. The products resulting from such electrolysis may then give rise to local electronic or ionic bombardment. The fact that some of this bombardment struck the cathode focusing device suggests that the action is, in part at least, due to positive ions.

The longest life obtained with this type of tube—forty hours—is short in comparison with that of the Universal type. It should be noted, however, that a life of forty hours at 30 ma. is equivalent to 240 hours at 5 ma.

For shorter periods of time we have operated experimental tubes at 50 ma. and 200,000 volts, and, with suitable design, they run, if anything, more smoothly at high milliamperage than they do at low milliamperage.

It seems very probable that, in the near future, it will be found possible to build tubes for 50 or 100 ma. at 200,000 volts to operate in water-cooled oil.

It is not yet certain that the preceding is the best method for taking care of the limitations. Another way of doing it lies in the use of a water-cooled target. This would permit operation of the tube in air. We are testing out this method in competition with the other.

The facts derived from this experimental work are also likely to make it possible to safely operate tubes at voltages in excess of 200,000.

The question naturally arises as to the desirability of increasing tube capacity. It would seem quite desirable from the standpoint of the patient, provided the physiological effect is not impaired. This point would, of course, have to be settled experimentally. The advantage of having one tube capable of handling the entire output of the machine rather than several tubes operating in multiple is, of course, obvious, as it greatly simplifies the high tension circuit.

The interrupterless type of machine with a four-arm rectifying switch appears to be well adapted to the use of currents of 50 or 100 ma. at 200,000 volts.

IV.

Methods of Increasing Efficiency of Production of Short Wave-Length X-Rays

Having considered the question of the tube capacity, let us ask whether the efficiency of production of short wave-length x-rays can be raised. We have done quite a little experimental

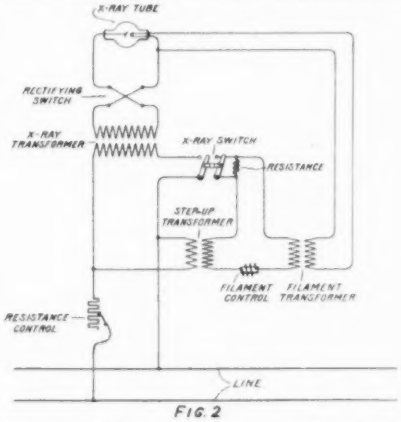

Fig. 2—Wiring diagram of x-ray outfit with stabilizing connection.

work on the following two methods of doing this: (a) by using a target material having a higher atomic number, and (b) by using a constant-potential continuous-current machine.

(a) Uranium Target—The work of Kaye in 1908[3] with a large number of metals used as target materials, showed that the efficiency of production of general radiation increased with increasing atomic weight.

Barkla and Sadler had also shown that the wave-length of the characteristic radiation decreased with increasing atomic weight of the target material.

These considerations made it interesting to try uranium. It has the highest atomic weight of all the elements, and had not previously been used, for the reason that it was not available in suitable form. For the purpose of trying it as an x-ray target, uranium was finally prepared in a dense coherent form by Dr. R. W. Moore[4], and tar-

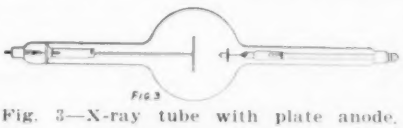

Fig. 3—X-ray tube with plate anode.

gets for experimental high-voltage tubes were made from it.

Using a high-voltage tube with a tungsten target and one with a uranium target, comparative measurements were made of the x-ray intensity under different thicknesses of copper. The tubes were operated with a current of 0.5 milliamperes and 225,000 volts (max.) The results are given in Table II., in which the x-ray intensities in the second and third columns were measured by means of an ionization chamber.

It is evident from the fourth column of Table II., that, under the same conditions, the efficiency of x-ray production from the uranium target is only a few per cent greater than from the tungsten target.

With a one millimeter copper filter the percentage depth-dose beneath ten centimeters of water was also measured with the same tubes, with the following results:

1—On interrupterless machine at 225,000 volts (max.), percentage depth-dose with tungsten, 18.3 per cent; percentage depth-dose with uranium, 18.9 per cent.

2—On continuous-current, constant-potential machine at 200,000 volts: Percentage depth-dose with tungsten, 18.9 per cent; percentage depth-dose with uranium, 19.5 per cent.

From the standpoint of percentage depth-dose, there is, then, but little advantage in uranium over tungsten as a target material. This is due to the fact that the characteristic radiation of even uranium is of too long wave-length to be very effective, at such high voltage and such heavy filtration, in reducing the average (effective) wave-length.

(b) Constant potential continuous current machine—The increased efficiency, in the production of short wave-length x-rays, to be derived from the use of a constant-potential continuous-current machine has been discussed by Coolidge and Kearsley[5]. They found that the constant-potential continuous-current machine at 200,000 volts, with one millimeter copper filter gave, for the same milliamperage, the same x-ray intensity as the interrupterless machine at 235,000 volts (max.) Under these conditions, the percentage depth-dose measured under ten centimeters of water was also the same in both cases.

Since the publication of the paper referred to, so many inquiries have been made concerning this machine that it is perhaps advisable to define its present status. In the laboratory, it has been operated for limited periods of time, with small tube currents and with voltages up to 200,000. Four storage batteries are used to light the filaments of the four kenotrons and these batteries, of course, require attention. There are two kenotrons in series on each side of the system and there is some difficulty in making these kenotrons divide the voltage equally between themselves.

Similarly, each condenser consists of several units connected in series and there is a corresponding difficulty in making the condenser units divide the potential equally between themselves. thousandths of an inch.

TABLE II.

Millimeters of Copper	X-Ray Intensity A Uranium	B Tungsten	A / B
0.5	22.05	24.00	1.09
1.0	15.20	15.93	1.05
2.0	9.43	10.32	1.09
4.0	4.97	5.25	1.06
8.0	1.75	1.84	1.05

The authors cannot recommend the outfit in its present condition for anything more than experimental work.

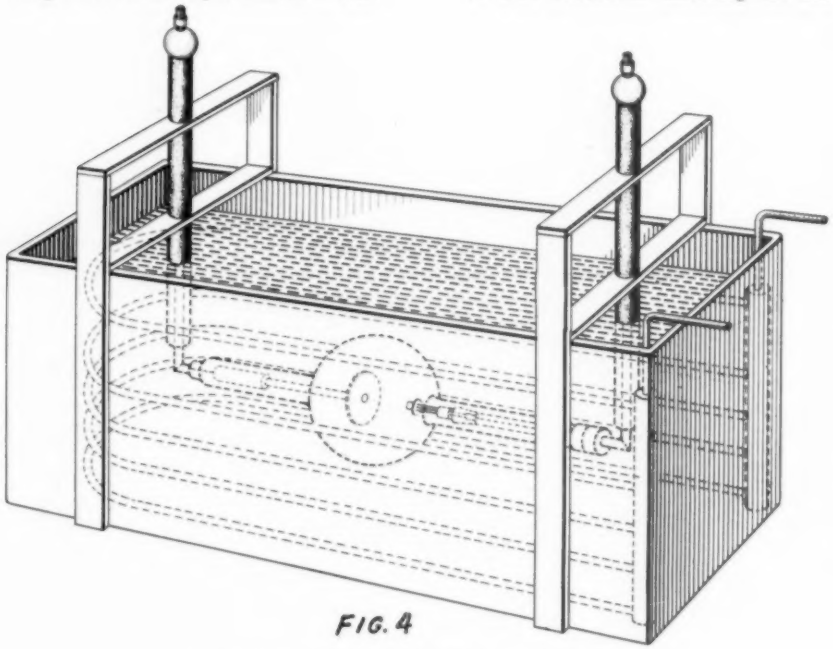

Fig. 4—Oil-immersed high voltage x-ray tube.

V.

SUMMARY

1. The conditions affecting the life of the Universal type high-voltage are discussed.

2. A new experimental type of high power high voltage tube, capable of carrying as much as 30 ma., at 200,000 volts is described.

3. A high-voltage tube has been made having a target of pure uranium, and data are given showing how the x-ray output and the percentage depth dose obtained from this tube compared with those obtained from a tungsten target tube.

4. The present status of the direct current constant potential machine is discussed.

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1. High Voltage X-ray Work. Am. J. Roentgenol., 9:99, Feb., 1922.

2. The better behavior of the tube with forced air circulation may be due to cooling of the glass or to the removal of ionized air from the neighborhood of the bulb. In this connection, it is of interest to note that in work which has been carried out, since the reading of this paper, in a high voltage tube with a water-cooled anode, in which there is but slight heating of the glass, forced air circulation is not necessary even with as much as 50 milliamperes.

3. Kaye, G. W. C. Phil. Trans. Roy. So. A., 209, page 123.

4. Trans. Am. Electro-Chem. Soc., 1923.

5. Am.. J. Roentgenol., 9:86, Feb., 1922.

X-Rays and X-Ray Apparatus; An Elementary Course*

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MEASUREMENT OF WAVE-LENGTH

99 IT SHOULD now be evident that for an accurate description of the character of x-rays, the terms hard, medium and soft are extremely vague. Penetration depends on the wave-length and the only accurate method of stating the quality of a beam of x-rays is to give its wave-length or the range of wave-lengths which it contains. Should the range be very limited, the beam may be considered homogeneous or monochromatic; if a wide range is covered, heterogeneous. An analogy from ordinary light will perhaps be useful. A beam of white light from the sun or an incandescent lamp is very heterogeneous, analysis by a spectroscope showing it to be a mixture of wave-lengths covering a wide range (all, however, very much longer than x-rays). On the other hand, if a piece of pure red glass is placed in the path of the white beam, the light emerging from the glass is approximately homogeneous. We call it a red beam, but might better describe it by saying the mean wave-length is in the neighborhood of 6200 A. U.

In radiology, therefore, it is of the utmost importance to know what kind of x-rays are being used. In treatment especially, real advances are possible only by the use of homogeneous rays whose effective wave-length is known. Fortunately advances of the last few years are making it an easy matter for medical men to make the necessary measurements. Comparatively simple x-ray spectrometers or spectrographs are now on the market by means of which direct readings of wave-lengths are readily made. For the intelligent use of such instruments, however, it is necessary to know something of the principles on which they are based. In the following paragraphs a brief explanation of these is given.

REFLECTION OF WAVES

100. All readers are familiar with the fact that a beam of ordinary light such as AB, Figure 81, is regularly reflected by a mirror along the path CD, in such a direction that the angle 1 is equal to the angle 2 (angle of incidence = angle of reflection). Now such regular reflection is true for any kind of wave-motion provided the surface of the reflector is smooth. By "smooth" is meant a surface with irregularities

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which are of the same order or smaller than the length of the waves. If circular waves on the surface of water spread out from a source S, Figure 82, until they strike a smooth wall at XY, they are regularly reflected in a manner indicated by the dotted lines. Again, if what we call plane water waves strike a reflecting surface obliquely, as in Figure 83, the waves are again regularly reflected as illustrated. It will be seen that this case is exactly similar to that illustrated in Figure 81.

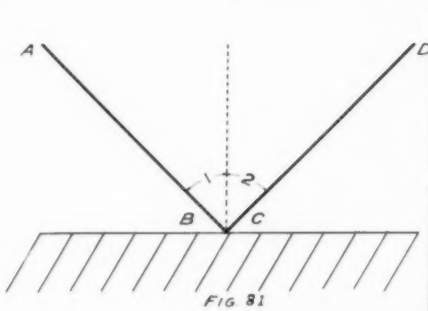


FIG. 81

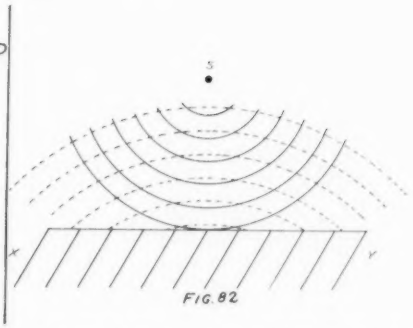


FIG. 82

101. The important question now arises, is a beam of x-rays reflected in the same way? Before 1913 experiments to answer that question all gave a negative answer, for a reason which should now be evident. The lengths of x-ray waves are so short that it is not possible to manufacture a smooth enough mirror. The irregularities of even the smoothest surface made are large compared with the wave-lengths of x-rays and regular reflection in the ordinary sense is not possible. But what man cannot do, Nature sometimes can, and this proved to be true in the case of x-rays. The regular arrangement of atoms in a natural cleavage plane of a crystal provided the necessary "smooth" reflecting surface[1].

Once Laue had proved by means of a crystal that x-rays were ether waves, it remained for the fruitful genius of the Braggs to establish the use of cleavage planes of crystals as reflectors, and so to open up a field of investigation which now includes many workers. One direct result of the pioneer work of the Braggs is the x-ray spectrometer.

The X-Ray Spectrometer

102. To understand the fundamental principles on which this instrument is based, it is necessary first of all to realize that the reflection of x-rays from the face of a crystal is not exactly the same as the cases described in Sec. 100. Since x-rays penetrate matter, *we have to do with a series of reflections from successive parallel planes of atoms.* A glance at Figure 84 will help to make the matter clearer. In this figure the rows AB, CD, EF, etc., represent a simple arrangement of atoms in successive parallel planes. If now a beam of x-rays is incident as shown, there will be reflected beams from AB, CD, EF, etc. (in the figure an attempt is made to show reflected beams from EF and GH) and it is natural to ask, will all these beams unite to form a single intense beam? In general, *they do not*, and herein lies the basis of the measurement of x-ray wave-lengths. To understand the reason something must be said about the principle of interference.

103. If two stones are thrown into a pond, at A and B ,Figure 85, it is a matter of common observation that the resulting sets of circular waves travel through each other. The illustration, therefore, represents a snapshot picture of a portion of the surface of the water, heavy lines indicating crests of waves, dotted lines troughs. It will at once be noticed that at all points marked O, a crest from A exists at the same time as a trough from B, and that consequently at such points *the surface of the water remains in its normal position.* At other points marked "x" a crest (or a trough) from one source is always met by a crest (or a trough) from the other, with the result that at these places there is a big movement of the water. In other words, *at some places the effect of one wave train may annul the effect of another, while at other places the two sets may reinforce each other.* Suppose, now, we are dealing with a beam of homogeneous x-rays. If Figure 84 is examined again, it will be seen that waves reflected at GH have to travel a path which is longer than the path of those reflected at EF; similarly waves reflected at AB a path longer (by an equal amount) than waves from CD, and so on. If this path difference is *exactly* equal to the wave-length of the rays, crests of one reflected beam will always meet crests of another, and consequently all the beams will reinforce each other. In other words, when this is the case, the total intensity of the reflected beam will be very great. In general, however, the path difference will *not* be exactly equal to one wave-length and the intensity of the reflected beam is very feeble. The importance of this point can scarcely be over emphasized. *It means that when a beam of homogeneous x-rays is incident on the face of a crystal, there is a reflected beam of marked intensity only when the path difference between the beams reflected from any two successive planes is exactly one wave-length*[2].

Should a heterogeneous beam be incident on the face of the crystal at any given angle, as in Figure 86, it follows that there will be an intense beam in the usual reflected direction (angle of incidence = angle of reflection) *only for that component* of the mixed beam for which the path of difference is one wave-length. This path difference, therefore, is a very important quantity. It can easily be shown that its value depends on, (1) the angle which the beam makes with the face of the crystal, (2) the distance between successive planes of the crystal[3].

As for any given crystal the distance between successive planes is a fixed quantity, it follows that when a beam of x-rays is allowed to strike the face of a crystal at a series of different angles, for each angle the path difference has a characteristic value. Consequently, if the beam contains several different wave-lengths, analysis of the mixture is possible because *each component is strongly reflected in a direction different from any of the others.* This is the fundamental principle underlying the construction and use of all instruments for measuring x-ray wave-lengths. It is applied in several different ways, three of which we shall note as being of especial interest to the roentgenologist.

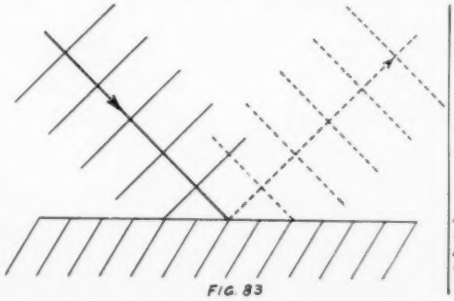


FIG. 83

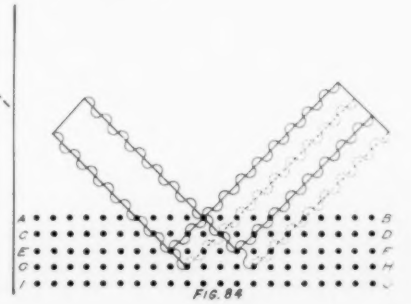


FIG. 84

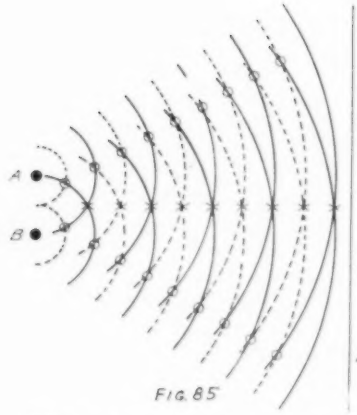


FIG. 85

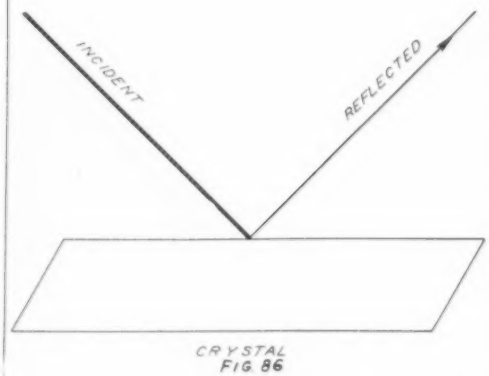


FIG. 86

Wave-Length by Rotating Crystal and Ionization Chamber

104. The arrangement as used by Dr. Duane (after Bragg) should be clear from a study of Figure 87. A narrow beam of rays emerging from the slits S_1 and S_2 cut in thick blocks of lead is incident on the face of a crystal C set on the table of an instrument called a spectrometer. By means of a scale attached to this instrument rotations of the crystal through small angles may accurately be measured. A third slit S_3 is so placed that any reflected beam which exists may enter an ionization chamber (I) placed immediately behind it. For this to be the case the slit S_3 and chamber must, of course, be placed so that the line OS_3 makes the same angle with the face of the crystal as the incident beam. For each position of the crystal, there is, therefore only one correct position of the second slit and the ionization chamber, both of which accordingly are mounted on an arm by means of which they may be rotated about the central axis through O.

In actual use the incident beam of x-rays to be analyzed is allowed to strike the face of the crystal at a number of different angles; for each angle the second slit and the ionization chamber is set in the correct position and the ionization current measured. A graph is then made (see Sec. 107) showing the way in which the ionization current varies with the angle of incidence. From this graph it is not a difficult matter to determine the constituent wave-lengths of a complex beam, since, as already noted, the path difference depends on the angle of incidence and is equal to one wave-length for that component which is strongly reflected.

The Seeman Spectorgaph

105. This instrument, specially designed for radiologists, differs from the type just described, chiefly in the use of a photographic plate instead of an ionization chamber. It is small and compact, and for its operation does not require as much experimental skill as the Bragg spectrometer. The beam to be analyzed enters the instrument by a narrow slit S_1, Figure 88, is incident on the face of a crystal immediately behind which a second narrow slit S_2 allows any reflected beam which may exist to emerge and finally strike a small photographic plate placed at AB. By means of a clockwork mechanism the portion of the instrument holding the crystal and photo plate is kept in a regular oscillating motion about the second slit as axis. In this way the original beam strikes the crystal behind S_2 at a series of different angles and regular reflections of each component takes place just as in the instrument already described. In this case, however, the "separated" beams fall on a photographic plate and a permanent record is obtained. Fundamentally, wave-lengths must be calculated in exactly the same way as in the first method, but with each instrument, the manufacturer provides a scale by means of which wave-lengths may be read off directly from the photographic plate. The instrument is, therefore, extremely convenient for the practicing radiologist.

The Roentgen Spectrometer of March, Staunig and Fritz

106. This instrument[4], which is designed primarily to measure the *shortest* wave-length in a mixture, is even simpler in its operation than the Seeman spectograph. By means of two slits, S_1 and S_2, Figure 89, a narrow beam of the rays to be analyzed passes *through* a crystal and is incident on a fluorescent screen. If the crystal is rotated it will be seen that reflections may take place internally from its parallel planes, somewhat as illustrated in the grossly exaggerated figure. By gradually rotating the crystal, therefore, a position will be reached when the angle of incidence is such that the shortest wave-length in the beam is intensely reflected. (The shortest wave-length appears first because it corresponds to the smallest angle between beam and face of the crystal). In this instrument this will be evident by a flashing up of the fluorescent screen at a definite place (λ_0 in Figure 89).

Moreover, rotation in the opposite direction will give rise to a reflected beam on the other side of the central one, which will give a second fluorescent region at λ_0'. In the type of instrument on the market, therefore, the crystal is rotated in both directions and the position of the two fluorescent regions noted with reference to a scale provided. From this scale the *shortest* wave-length in the beam is read off. The importance of a knowledge of the shortest wave-length will be discussed later (Sec. 107).

107. We are now in a position to learn something of the results which have been obtained by means of x-ray spectrometers, as well as by the earlier but less exact absorption methods. (1) The beam of rays leaving the target of any tube, even when the voltage operating it is constant, is far from homogeneous. A good example of the analysis by means of an x-ray spectrometer (of the Bragg type) is found in Figure 90, where the graphs illustrate some results obtained by Dr. Duane of Harvard University. Curve A shows the way in which the ionization in the chamber of the spectrometer varies as the chamber is set so that reflected rays enter at different angles, or, in other words, it gives the relative intensities of the different wave-lengths into which the composite beam has been anaylzed. We see that it represents a beam with wave-lengths ranging from about 0.33 A.U. to about 0.85 A.U., with intensity reaching a maximum at wave-length 0.5 A.U. In this case a constant but not specially high voltage was applied to the tube.

Now, it is because of such measurements that we can state, as has already been done, that x-rays used in radiology have wave-lengths ranging from 0.06 A.U. to 0.3 A.U.; and that we can

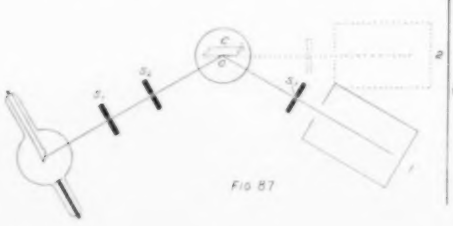


FIG. 87

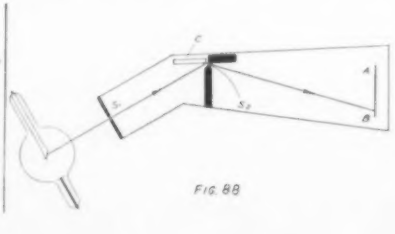


FIG. 88

say that soft rays are those with wave-lengths in the neighborhood of 0.3 A. U., while hard rays have wave-lengths of the order of 0.1 A.U. X-ray spectrometry, moreover, has shown that, in general, the shorter the wave-length, the more penetrating the rays. To take a concrete example, for λ (symbol for wave-length) = 0.1 A.U., the value of D (the half absorption value (see Section 81) is equal to about 640 mm. of aluminum; for λ = 0.2 A.U., D = 12.2 mm. of aluminum, while for λ = 0.3 A.U., D = 5.7 mm. of aluminum. Once more, then, we emphasize the fact that to give the wave-length or effective wave-length is the most exact way of describing the quality of a beam of x-rays.

(2) The *shortest* wave-length in a mixture depends absolutely and only on the maximum voltage across the tube. This is true whether the potential is constant or variable. If the crest value of the voltage across a tube operated by a transformer is the same as a constant voltage applied to another tube, the shortest wave-lengths emitted by the two tubes are identical. What is even more important, by means of the simple relation given below, the value of the shortest wave-length can be easily calculated.

$$\text{Shortest wave-length} = \frac{12354}{\text{Maximum voltage}} \text{ A.U.}$$

For example, with 80,000 volts (maximum or crest) across a tube, the

$$\text{shortest wave-length} = \frac{12354}{80000} \text{ or}$$

.15 A.U. With 250,000 volts (deep therapy), the shortest wave-length

$$\text{emitted is } \frac{12354}{250000} \text{ or } 0.049 \text{ A.U..}$$

While the shortest wave-length is by no means the most intense (see Fig. 90 again), a knowledge of its value gives a fair indication of the quality of a beam of rays. In many cases, according to Kaye, the wave-length of the greatest intensity is about 1.2 times that of the shortest component.

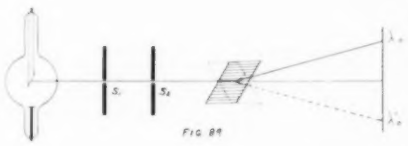
The X-Ray Spectrometer as High Tension Voltmeter

The above relation may evidently be written,

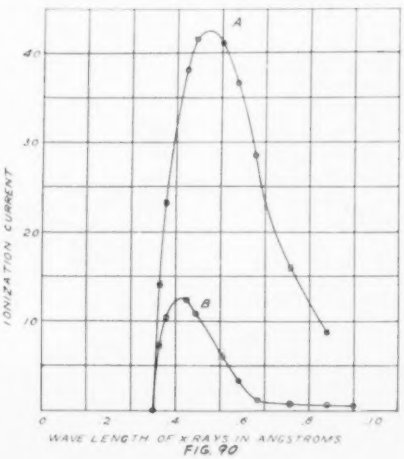
$$\text{maximum voltage} = \frac{12354}{\text{shortest wave-length}}.$$

If, therefore, the wave-length can be read off from a scale provided in an instrument (as is the case in the Seeman Spectrograph) we are thus provided with a new and an accurate means of measuring the highest voltage. Indeed, the accuracy of this method exceeds that of any of those discussed in Section 16 (3). The rays leaving the target of an x-ray tube may consist of two kinds, (a) a general or independent or "white" radiation, (b) a characteristic radiation. An example of general radiation has already been given in Figure 90, where, as we have already noted, we have to do with a whole *range* of wave-lengths running *continuously* from a lower to a higher limit. In this case the magnitudes of the wave-lengths emitted are independent of the material of which the target is composed.

On the other hand, characteristic radiation consits of a certain few *isolated* wave-lengths whose magnitude depends on the material of the target. A very exact analogy is found in the



case of ordinary "visible" light. If the light from a carbon arc is observed through a spectroscope, or, having passed through a prism, is allowed to fall on a screen, one sees a *continuous* spectrum having all colors ranging from red to violet. If, while the carbon arc is still burning, it is fed with a small quantity of a salt of some element, such as barium, for example, one sees superimposed on the continuous spectrum, certain isolated narrow colored bands, spectral lines, as we call them. Should the nature of the salt be changed, the same phenomenon would be observed with, however, the colored lines in different positions. In other words, the number and position of these spectral lines depends on the substance put in the arc and are characteristic of it. To return again to x-rays, the continuous spectrum corresponds to the general radiation, while the isolated lines are exactly analogous to the characteristic radiations.



Independent or General Radiation

108. It is necessary, now, to say something about each of these types of radiation. Figure 90 is fairly typical of the distribution of wave-lengths in the general beam. Regarding the manner in which they range from the shortest wave-length through one of maximum intensity to a limit on the long wave side, sufficient has already been said. One further point, however, may be noted. The *total* intensity of the beam of general rays has been measured under different conditions and it has been shown to depend on, (a) the current through the tube. Double the current, the intensity is doubled; that is, the intensity is directly proportional to the current. (b) The voltage across the tube. Double the voltage, the intensity is quadrupled; that is, the intensity depends on the *square* of the voltage. (c) The atomic number of the material of which the target is made. The higher the atomic number, the more intense the beam. For example, under the same conditions of current and voltage, a tube with tungsten target (atomic number 74) emits a beam whose intensity is less than a tube with platinum target (atomic number 78)

$$\text{in the ratio } \frac{74 \times 74}{78 \times 78}.$$

It follows, therefore, that when increase in intensity is desired, something is gained by using targets of as high atomic weights as possible.

Characteristic Rays

109. (1) A photograph taken with a Seeman spectograph or any similar instrument, reveals (a) a continuous blackening across the plate ending at the shortest wave-length of the general radiation and (b) *if the voltage is high enough*, certain isolated black lines superimposed on the continuous background. These lines are due to the characteristic radiations emitted by the target, and as already noted, have definite wave-lengths which may be accurately measured. Figure 91, a reproduction of a photograph taken by Mueller[5], gives an excellent example of the photographic appearance of characteristic x-ray spectral lines.

Experiments with ionization chambers and the Bragg type of spectrometer show the same phenomena. Figure 92 (a rough copy of one due to Dr. Duane) shows the type of curve obtained when a much higher voltage is across the tube than was the case in Figure 90. The high peaks in the curve of Figure 92 are obviously an indication of the fact that in the beam there are certain *isolated* wave-lengths

of marked intensity. These are the characteristic radiations of tungsten. Should a tube with another target be used, there would be peaks corresponding to different wave-lengths, just as in the photographic method the narrow spectral lines would occur at different places on the plate. With tungsten, characteristic radiations are observed at wave-lengths 0.179, 0.184, 0.209, .213 A.U. (Henceforth we shall omit the unit,, all wave-lengths being given in Angstroms). Change to uranium, however, and peaks occur at 0.111, 0.126, and 0.131.

(2) Characteristic rays do not appear unless the voltage across a tube is sufficiently high. In the case of tungsten, for example, potentials of the order 80,000 to 100,000 volts are necessary, while in the case of uranium, characteristic rays do not appear until nearly 115,000 volts have been used. This has an important practical application. Because of the possible presence of characteristic rays in a beam it follows that its mean quality cannot be fixed *solely* by even an accurate knowledge of the crest voltage. It depends also on the material of which the target is made. Once more, then, we are made to realize that an exact knowledge of the electrical conditions under which a tube is operating is not enough for an exact knowledge of the quality of the beam leaving the tube. When using 80,000 to 100,000 volts, tungsten would be a better target to use than uranium, because this voltage is not sufficient to bring out the characteristic rays of the latter.

If the voltage necessary to bring out a set of characteristic lines of one element is known, that necessary to excite those of another element may readily be found from Moseley's law. Once more it is a question of atomic number. The required voltage is proportional to the square of the atomic number. Platinum, for example (N = 78) would require a voltage higher than tungsten in the ratio $\frac{78\times78}{74\times74}$, while uranium (N = 92) requires a much higher potential than either of these. On the other hand, the higher voltage excites shorter wave-lengths in the case of the elements of higher atomic number. This is clearly shown in Table XVI, where corresponding prominent characteristic wave-lengths of four elements are given.

TABLE XVI.

	Copper	Silver	Tungsten	Uranium
Atomic number	27	47	74	92
Wave-Length	1.54	.56	.21	.15

An analysis of all the characteristic wave-lengths emitted by a single element shows that they may be divided into groups. These may be explained by taking tungsten as a typical example.

TABLE XVII.

Group 1 K	Group 2 L	Group 3 M
.213	1.67	6.97
.208	1.48	6.75
.184	1.47	6.09
.179	1.42	....
....	1.30	....
....	1.28	....
....	1.25	....
....	1.26	....
....	1.20	....
....	1.09	....
....	1.06	....
....	1.03	....

A glance at Table XVII will show the existence of the three sets of wave-lengths which are universally designated by the letters K, L and M. It will be seen from the numerical values that the L and M series have wave-lengths too long (that is, are too soft) to be of any use in radiology. They are absorbed by the walls of an ordinary x-ray tube, and have no practical interest for the radiologist. The K series, however, is important because in the case of all elements of high atomic number, all the wave-lengths which it comprises are within the useful range in radiology.

110. At one time it was thought that it might be desirable to construct tubes with uranium targets and so to make use (in deep therapy) of the characteristic rays of this element, with a minimum wave-length of 0.105 as compared with .179 for tungsten. Now, however, the aim is rather to build tubes which will stand higher and higher voltages and so to utilize the short waves of the general beam. "A voltage as high as 3,000,000 could probably be produced, and, if a suitable tube could be developed, it would probably be possible to operate it from such a source, in oil, not in air, as the spark length would be close to thirty feet' (Coolidge). Applying the relation given above, this voltage would give rise to a minimum wave-length of $\frac{12354}{3{,}000{,}000}$ or 0.004 A.U. In the meantime most roentgenologists will probably find that there is ample for them to do with a 250,000 volt machine.

To sum up, then, the beam of rays leaving an x-ray tube comprises a whole range of wave-lengths whose shortest magnitude may readily be found, but whose general character may be complicated by the presence of certain rays characteristic of the metal of the target. By means of an x-ray spectrometer, however, it is possible to make an accurate analysis of the mixture *in terms of universal standards*. There need, therefore, be no confusion when different radiologists report the character of radiations used.

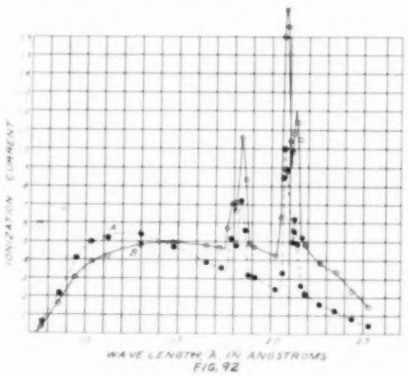


FIG. 92

111. There is another matter, however, which is not quite so simple. For effective progress in the use of x-rays for treatment, it is desirable to utilize beams as homogeneous in character (that is, as monochromatic, to borrow a term from light) as possible. Obviously one wave-length may be more effective in treatment than another[6].

Can this homogeneity be obtained? The ideal way consists in the use of a spectrometer for isolating a small range of wave-lengths. Practically this is not so simple a matter as the mere analysis of the beam by the methods described above, and for most radiologists the less accurate but extremely useful method of filtration is the only method. In this connection we may state here that homogeneous beams of greatest purity are obtained by operating a tube on a voltage somewhat

Fig. 91

greater than that necessary to bring out the characteristic rays of the target, together with suitable filter. But even in the case of an element with such a high atomic number as uranium, the resulting wave-lengths are not short enough for deep therapy and in practice the radiologist uses a much higher voltage and the resulting short wave-lengths of the general beam.

Filtration and Wave-Length

112. The general principles of filtration have already been discussed (Sec. 84). We are now, however, in a position to examine this question in the light of the accurate wave-length analysis which the x-ray spectrometer has made possible. Some of the important results shall be noted.

(1) Rays which, according to the absorption method (Sec. 84) have been made homogeneous by filtration, are by no means monochromatic; that is, such filtered rays also consist of a mixture of many wave-lengths. Curve B (Fig. 90), for example, shows the effect of a filter of aluminum on the beam for which curve A gives the unfiltered analysis. Generally speaking, however, the filter absorbs long waves (soft rays) more than those of short wave-length and the beam is thereby made both more penetrating, on the average, and more homogeneous.

(2) Beyond a certain minimum value, increased thickness, while it reduces the intensity of the beam, gives rise to but little gain in homogeneity.

(3) The shortest wave-length is not affected by the filter, as is clearly shown in Figure 90. The relation connecting the value of the shortest wave-length with the applied voltage applies equally to filtered and unfiltered rays.

(4) Care must be exercised in the choice of a suitable metal for filter. We can readily obtain sheets of iron, copper, lead, aluminum, zinc and tin. Are all equally suitable? The answer to this question is found in some very important measurements on what are called critical absorption wave-lengths of the elements, the values of which for the above common metals are given in Table XVIII.

TABLE XVIII.

Critical Absorption	Wave-Lengths
Aluminum	7.95 A.U.
Iron	1.74
Copper	1.30
Zinc	1.30
Tin	0.42
Lead	0.14

In so-called *normal* filtration, which we have been discussing (and this is the kind of chief interest to the radiologist) a filter is effective because it absorbs the long soft rays more than short harder ones. But this is not always the case, because for every element there is what is called a *critical absorption wave-length*. This simply means that all waves shorter in length than this critical value are absorbed *more* than those longer. To take a concrete case, lead absorbs all wave-lengths less than 0.14 A.U. (see Table XVIII) much more than those longer than this critical value. Now wave-lengths shorter than 0.14 are the highly penetrating kind which are utilized in deep therapy. It follows, therefore, that a filter of lead would be practically useless for normal purposes. There is, however, no serious objection to any of the other metals given in Table XVIII, because *all* the wave-lengths used in radiology are below the

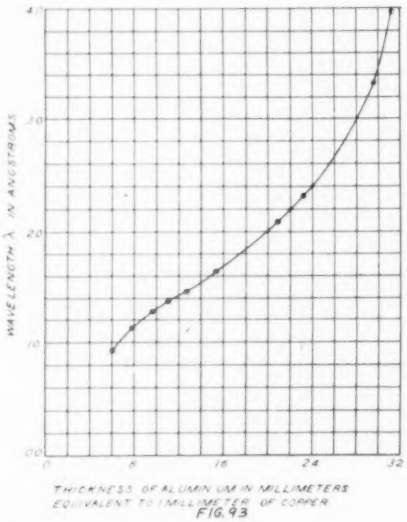


FIG. 93

critical absorption wave-lengths. In actual practice filters of aluminum, copper, zinc and brass are in general use.

(5) On the other hand, even in the case of metals, all of which are suitable for normal filtration, one may be better than another. For example, Duane has shown that 1 mm. of copper is more effective than 12 mm. of aluminum in absorbing waves longer than 0.141 A.U., but less effective for waves shorter than this value. That this is the case will be evident from a comparison of the two curves of Figure 92. Curve A gives the analysis of a beam with a filter of 1 mm. of copper, curve B with a filter of 12 mm. of aluminum. It will be noted that at wave-length 0.141 the two curves cross one another. It follows, therefore, that if it is desired to have a beam with an excess of the shortest waves possible, copper is a better filter to use than aluminum.

The Effective Wave-Length

(6) It is hoped that it is now clearly evident that the only exact way of describing the character of a beam is by giving the relative intensities of its component wave-lengths. To do so, some type of x-ray spectrometer is necessary and such an instrument may not be in the possession of every radiologist. Such a man has always resource to the less exact penetrometers already described, but, thanks to the labors of Dr. Duane, it is possible for him, even without a spectrometer, to describe the quality of a beam in terms of its *effective wave-length*. By this is meant the wave-length whose coefficient of absorption is the same as that for the whole beam. "It is this effective wave-length which is important to determine in many cases —for the physiological effect of the rays appears to depend upon the amount of radiation absorbed" (Duane)[7].

113. To find the effective wave-length of a beam use must be made of the standard graph made from measurements taken by Dr. Duane and with his kind permission reproduced in Figure 93. (By consulting the original paper to which reference has been made a second method along similar lines will be found). The method depends on the fact already noted, that the relative absorbing powers of copper and of aluminum is not the same for all wave-lengths. For wave-lengths of the order of 0.1 A.U., for example, 7 or 8 mm. of aluminum are required to absorb as much as 1 mm. of copper, while for wave-lengths in the neighborhood of 0.2 A.U. it takes about 20 mm. of aluminum. For each wave-length, therefore, there is a definite thickness of aluminum which absorbs to the same extent as 1 mm. of copper. Now such equivalent thicknesses of aluminum have been determined by Dr. Duane for a whole range of wave-lengths and

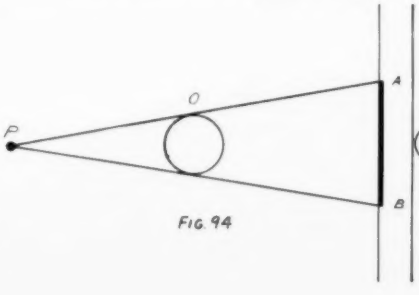


FIG. 94

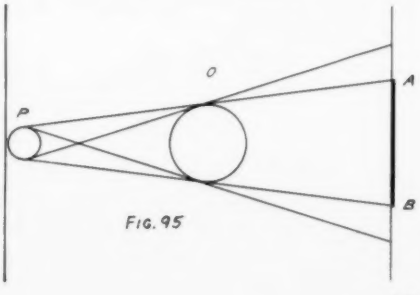


FIG. 95

the graph of Figure 93 gives the result. To use this graph for determining the effective wave-length of a beam, it is necessary first of all to determine by means of an electroscope or by an examination of the blackening of a photographic plate, how much the beam is reduced in intensity by 1 mm. of copper. Next the copper plate is replaced by increasing thicknesses of aluminum until a thickness is obtained such that the reduction in intensity of the beam is the same as for copper. Suppose it were 16 mm., then a glance at the graph of Figure 93 at once gives the wave-length which has the same absorption, as about 0.17 A.U. This, then, would be the effective wave-length of the beam.

In this connection one further point may be noted. Any thickness of copper may be used, provided the operator determines the *number of times* the aluminum thickness is greater than that of the copper. For example, in the case just considered, a copper filter of ½ mm. might be used, in which case the equivalent thickness of aluminum would be 8 mm., that is, sixteen times that of copper. The exact thickness of copper to be used would naturally depend on how penetrating a beam was utilized.

Focal Spot and Its Relation to Wave-Length

114. In earlier pages reference has been made to differences in the size of the focal spots on the targets of tubes. Before concluding this chapter, it is desirable to look at this question in the light of our knowledge that x-rays are short ether waves. Since this is the case, in radiography and fluoroscopy, the radiologist is dealing with shadow pictures, the details of which should be as clearly defined as possible. To obtain good detail, sharp shadows are necessary, and these can only be obtained by having a small source of rays, that is, a fairly fine focal spot. The case is exactly analogous to the shadow patterns of obstacles placed in the path of light rays. A small source of light such as P, Figure 94 (an uncovered arc lamp, for example) casts a sharp shadow AB of an object O on a screen. If, however, the source of light is comparable in size with the object, as shown in Figure 95, the portion of the shadow AB will be completely dark, whereas around it will be a region which receives light from some parts of the source, but which is cut off from other parts. The shadow is not sharp. In radiography it is exactly the same, and for good pictures it is necessary to have as fine a focus as the energy conditions (see Sec. 72) will allow. However, care should be exercised that rays generated from parts of the tube other than the focal spot (as sometimes happens, since wherever electrons hit, x-rays originate) are not allowed to fall on the body to be examined.

On the other hand, in treatment it is a question solely of the absorption of radiation and there is no need whatever to have a fine focus. Indeed, as in treatment a tube is generally operated continuously for some time, it is highly desirable that such be not the case.

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1. Because in a cleavage plane of a crystal we have to deal with a sort of lattice arrangement of atoms and "spaces" alternating, the reflection of which we speak is not exactly the same as that of ordinary light from a mirror.

2. This will also be the case for path difference exactly equal to two, three, etc. wave-lengths.

3. The actual value of the path difference $= 2\ d \sin \theta$, where d is the distance between successive planes, and θ is the angle between the direction of the incident beam and the face of the crystal. For a simple proof see "X-rays and Crystal Structure," p. 16, by Bragg and Bragg.

4. The Physical Society of London, Vol. 35, Part 4, Page 45-D, June 15, 1923. American Journal of Roentgenology, 10:479, June, 1923.

5. Mueller: Phil. Mag., 42:419, 1921.

6. In this connection see recent paper by Russ on the effect of x-rays of different wave-lengths upon animal tissue. Proc. Roy. Soc. B 95, p. 131, 1923.

7. Duane: Am. J. Roentgenol., 9: 167, March, 1922.

X-Ray in the Various Forms of Infection.*

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THE IMMUNITY produced in cases of recurrent attacks of pharyngitis and tonsillitis furnishes a striking example of the efficiency of x-ray therapy in infection. This is especially evident in those patients whose pharyngeal tissues are constantly bathed in pus coming down from the chronically infected sinuses.

The biochemical change in the tissues has been attributed to a local stimulation of the phagocytes or to a chemical change worked by the x-ray in the pathological and local tissues. The clinical results are similar to those established in the production of immunity.

Fully 80 per cent of the cases, observed from one to three years, suffering from recurrent attacks of tonsilitis and pharyngitis have been relieved of this condition.

The infection in these cases involves not only the tonsils and the adenoids, but extends to the lymph structures on the lateral and posterior walls, the infratonsillar nodule, lingual tonsil, the lymph tissue in the fossa Rosenmueller and the cervical glands of the neck.

The surgical removal of tonsils and adenoids in delicate children is followed by pharyngitis due to the infection present in the adjacent lymph structures, thus retarding convalescence.

The small fibroid tonsil of the adult, so often associated with rheumatism and neuritis, is embedded in soft infected tissue. The pathological findings of the fibroid tonsil indicate that the infection is chronic in character and more or less controlled by the fibroid process as exemplified in other forms of infection. It is quite evident that the tissue surrounding the tonsil, as well as the adjacent lymph structures similarly infected, play an important role in producing the toxine necessary for the development of the symptoms produced by focal infection.

The removal of the embedded tonsil necessitates cutting or tearing through the tissue surrounding the tonsil and thus increases the possibility of dissemination of septic emboli into the blood and lymph tissues. On the other hand, the effect of the x-ray would cause not only a shrinkage and drainage of the lymph structures involved, but would also produce a local immunity by means of the biochemical change taking place in these tissues. By this means the surgical complications, lung abscess, septicemia, pneumonia and acute endocarditis may be avoided.

A small dose of x-ray frequently applied is the recognized standard treatment in dermatology of acne, lupus vulgaris, carbuncle, furunculosis and various other infections of the skin.

Hickey of Ann Arbor and later

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Kahn of Detroit have been able to clear the throats of diptheria carriers in from two to four days after a fractional dose of x-ray. These results were obtained in 80 per cent of the cases treated.

Schrader of Berlin reports his results in seven cases of erysipelas which were uniformly good. Complications (inflammation of the kidney), occurred in only one instance in which irradiation could not be begun until several days after the eruption of the erysipelas. The dose was one-sixth of an erythema dose. The day following the irradiation the reddening became less marked and the swelling subsided.

Kemp of Leipzig reports the healing under roentgen treatment of a circumscribed peritoneal suppurative process originating from an appendix or consecutive to abortion. Furuncles in the axilla also subsided under roentgen exposures after a small incision. Leg ulcers rebellious to other measures cleared up in forty-eight hours. Pneumonia, which seemed to suggest subacute or chronic suppuration was favorably influenced in several cases. A single large field was exposed using 20 to 40 per cent of an erythema dose.

The Italian official commission for the study of roentgen ray treatment of malaria states that this treatment is contra-indicated in acute malaria. Large doses may bring on a severe attack with extensive invasion of the blood stream by the parasites. Chronic enlargement of the spleen frequently subsides under irradiation. Some forms of malaria with infrequent attacks may be cured by roentgen treatment without drugs. The quinin-resistant forms should be treated with quinin again after the use of the roentgen rays.

Van Ree of Amsterdam, Holland, reports 470 cases of glandular lesions of the neck, axilla and groin. Improvement was realized in every instance, and a clinical cure in 85 per cent in a few months. The malignant type which develops fistulas early is more rebellious to roentgen rays and usually requires preliminary surgical measures. The benign type may be larger but retrogresses under a few exposures. A cheesy agglomeration of lymphomas may require six or eight exposures at three week intervals and after this a few treatments at three month intervals. The cheesy matter can be aspirated through a large needle or if located in a single gland can be excised. An abscess of the painless or benign type can be punctured during the exposures at three week intervals. Incision of the abscess is not advised. In the other types the painful glandular process if solitary should be excised followed by six x-ray exposures. When combined with an abscess, incision is indicated with one exposure a week, but it should never be given over red skin. The result is generally a scar and sometimes a fistula. When the abscess has already broken through the skin he recommends ample opening of the gland, scraping out the cheesy masses followed by a few exposures at three week intervals. Improvement occurs immediately and invariably after exposure of the tuberculous gland, but bone and joint processes are not amenable except those in small bones of the hand and feet, which give very favorable results. Amputation of fingers and toes is no longer necessary. Tuberculous processes in ribs, sternum and skull bones may be favorably influenced by radiotherapy. If there is a fistula it should be curretted and the exposures will complete the cure. He believes that tuberculous epididymitis responds to the roentgen rays as favorably as the glandular process.

Osmond of Cleveland says that the x-ray offers a method of preventing the acute catarrhal condition of the sinuses and antrum from becoming purulent and the acute purulent sinusitis from becoming chronic. Chronic suppurative sinusitis with granulations, polypi or necrosis of bone is the end result of the acute condition which every method of treatment seeks to avoid.

Garretson of Buffalo believes that infiltration of the lymphatic tissue of the peridental membrane of the teeth and the gums is the greatest factor in recurrent infections from pyorrhea. He has found that if these lymphatic areas are treated by x-ray that absorption takes place, pressure is relieved and the tissues recover.

Twenty-six cases of active pertussis were given roentgen-ray treatment by Bowditch and Leonard. The ages of the patients varied from three months to forty years. The patients were in different stages of the disease, varying from one to ten weeks. Each patient received three or four applications of the roentgen-ray at intervals of two or three days. The dosage was regulated according to the age of the patient and the total amount of roentgen ray given to any one patient was well under an erythema dose. There has resulted definite improvement in these patients, which the authors state cannot be explained by mere accident. In a small percentage of these twenty-six cases after two or three applications of the roentgen ray covering a period of six days, the spasms and whoops entirely disappeared and the patients were clinically well, except for possibly a very slight cough. The bulk of the patients were "relieved." There was a gradual diminution in the number of spasms.

Irons of Chicago believes that aside from the chronic suppurative lesions of the lungs which may be the source of distant metastases, there is an interesting group of cases in which the primary lesion is apparently at the hila of the lungs, and in which other areas of chronic infection can be excluded with reasonable certainty. These cases have been more numerous in the years since influenza has been epidemic.

The clinical features of this group are: recurrent arthritis, attacks of erythema, with nodular swellings resembling clinically erythema nodosum of erythema multiforme; frequently asthmatic seizures in adults not previously subjects of asthma, and definite peribronchial thickening, particularly of the lower lobes, with sometimes enlargement of the lymph nodes at hilum of the lung, as shown by fluoroscopy and thrytis and asthma may occur singly or roentgenograms. The erythema, artogether. The pulmonary condition has usually followed bronchopneumonia,

Fig. 1—Apparatus consists of an oil-immersed tension transfer and hot cathode x-ray tube in same tank. This is placed under the leaf at the end of the table. On the leaf is mounted an adjustable head rest with lead lined opening. On one side is the milliammeter filament control and also a switch for turning on the primary current. The filter is attached to the top of the transformer tank so that it can never be forgotten. Target distance is fixed.

and is not tuberculous. Periods of irregular fever of from 100 to 103, lasting from a few days to a week, occur, and with these febrile attacks come the erythema and arthritis. There is a moderate leukocytosis. Blood cultures, both aerobic and anaerobic, during the exacerbations of fever have usually shown no growth. Apparently, the infection is resident in the peribronchial tissues and lymph nodes at the hilum of the lung, and is therefore to be regarded as an unusual type of infection resident in a local lesion rather than as a renewed invasion of the body through the respiratory mucous membranes. The diffuse erythema and asthma suggest a protein intoxication possibly derived from the infecting bacteria or from the tissues affected by them. Several of these patients have been greatly benefited by therapeutic doses of the roentgen ray directed toward the tissues at the hila of the lungs.

Conclusions

1. It is evident that the adjacent lymph structures in the so-called cases of chronic pharyngitis and tonsillitis play an important role and that the tonsil and adenoid infection is only a part of the process.

2. The immunization produced in the tissues in the various forms of infection indicates that the x-ray fulfills the therapeutic requirements much better than any form of treatment directed solely to the tonsils and adenoids without subjecting the patient to any of the discomforts or complications attending other methods of procedure.

3. The evidence obtained from a review of the literature indicates that small doses of x-ray produce the most desired results.

4. The removal of tonsils and adenoids and the excision of breast in carcinoma both leave the involved lymphatics in the adjacent tissues.

5. Fully 80 per cent of the cases, observed from one to three years, suffering from recurrent attacks of tonsillitis and pharyngitis have been relieved of this condition by x-ray therapy. The same results are obtained in cases of recurrent pharyngitis in which the tonsils and adenoids have been removed.

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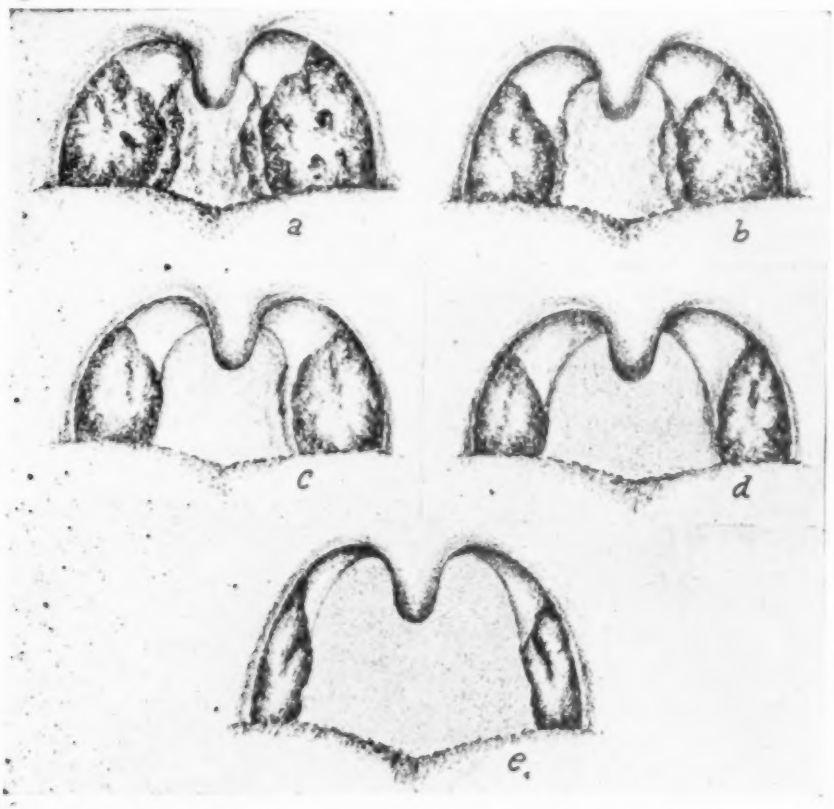

Fig. 2—(a to e)—**(a)** Tonsils before x-ray treatment; large, ragged, crypts contain pus. Large mass of lymphoid tissue behind posterior pillars. **(b)** Two weeks after treatment; tonsils reduced; surface smooth and clean. Mass behind pillars reduced. **(c)** Four weeks after treatment; tonsils markedly reduced, pale and smooth; no exudate on deep pressure. **(d)** Eight weeks after treatment; small amounut of exudate. **(e)** Six months after treatment; tonsils small, normal in appearance, no exudate on deep pressure. Lymphoid tissue behind pillars practically gone. Hemolytic streptococci disappeared from throat by second week after treatment.

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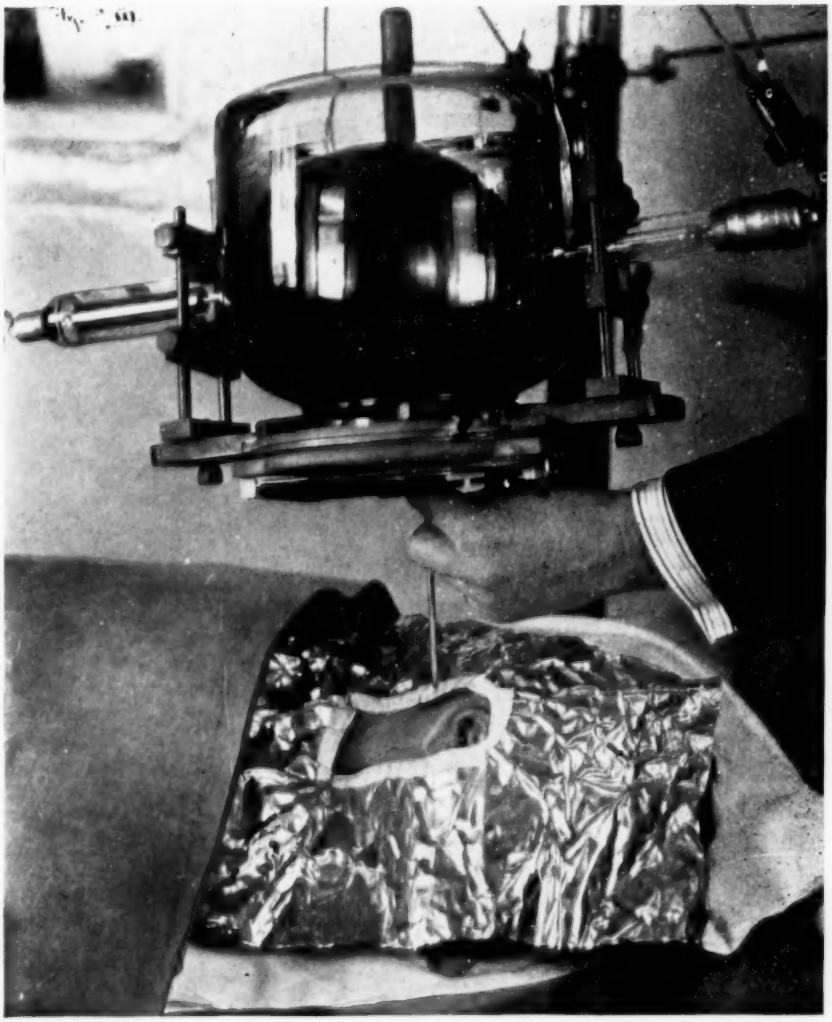

Fig. 3—Shows position used in treating tonsils with the ordinary x-ray treating tube stand resting above the patient. The rays are focused over the tonsils by an indicator as shown by the illustration. The surrounding part of the skin is covered with lead foil. The routine factors are 7-inch spark gap, 5 ma., 10-inch distance, 4 min., 3mm. Al. One treatment is given over each tonsil every two weeks until eight have been given. Two months after the last treatment the patient is again examined and is then given further exposures if necessary.

EDITORIAL

The JOURNAL OF RADIOLOGY

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The Field of Physiotherapy.

THE FIELD of physiotherapy is very broad, as is well known by those who have had experience in its use. On the other hand the great help to be gained by its use in medicine is but poorly understood by the rank and file of the medical profession. At the twenty-fifth annual meeting of the American Hospital Association attention was forcibly called to the value of physiotherapy by Kellogg, the pioneer in this work in America. "A department of physiotherapy may not be needed by every hospital, but every hospital needs physiotherapy and a physiotherapist," are his own words. He might have gone still further by calling attention to the fact that every physician needs to employ physiotherapy in his daily private practice.

Medicine advances by periods. It has not been so long since the days of the barber-surgeons who were qualified to let blood. This act being based on the theory that all disease was due to some "humor in the blood."

The invention of the microscope, leading to the discovery of bacteria showed many diseases to be due to specific organisms. This knowledge in turn acted as the foundation for present day preventive medicine as well as making modern surgery possible.

After all, at present, we know of but few specific medicines. So that most diseases must still be combated by measures which build up the combating power of the individual. This means, to quote further "* * * with very few exceptions, the agents which are really patent in combating disease are those which modify the blood or the blood supply and these agents are almost wholly those which belong to the field of physiotherapy which includes all therapeutic measures other than drugs and psychic influences."

This definition makes physiotherapy include not only such phases of treatment as massage, passive motion, mechanotherapy, hydrotherapy, electrotherapy, actinotherapy, radium and x-rays, but even surgery itself. In calling attention to the importance of physiotherapy it is not our purpose to minimize either the value of surgery or the value of medicine, but on the contrary to emphasize the importance of certain physical methods which are of great help to the patient as well as to the physician.

Inadequate Instruction

The lack of general knowledge on the part of the medical profession of America as to the value of physiotherapy is due chiefly to the failure of our medical scools to teach this subject. Even at this time, when its importance is becoming more generally recognized there are few if any medical schools giving serious attention to this subject in their curricula. This means that several more generations of medical students will complete their courses under the present inadequate instruction. When the medical profession so grossly neglects the intelligent use of this important phase of therapy it is little wonder that cults have sprung up who misuse it and over advertise it.

Concrete Illustrations

Two concrete illustrations of the value of physiotherapy recently came to our attention. These two are typical of what is being duplicated in thousands of cases daily, but they are sufficiently striking to merit comment.

The one was a young woman who had suffered from asthma so severely that she had been compelled to sleep in the sitting posture much of the time for several years. A short course of physiotherapeutic treatments enabled her to sleep comfortably in bed without difficulty. During the treatments and after they had been completed she gained nineteen pounds in weight.

The other patient was a young man who had received a comminuted fracture of the lower end of the tibia, the fracture extending into the articular surface. Competent surgical treatment was given, but several months after union had occurred the patient's ankle joint was stiff and painful so that he was still compelled to use crutches. After a short course of physiotherapeutic treatments the pain disappeared and full function was restored.

Industrialists Demand It

The second case cited above is illustrative of the great numbers of industrial injuries which are so greatly benefited by intelligent use of physiotherapy. Indeed many of the large industrial concerns who provide medical care for their employees are insisting upon the treatment of their injured by these methods. No more illuminating illustration of the value of physiotherapy to industrial surgery is found than that of the U. S. Steel plant at Gary, Indiana. It seems that a large percentage of the injuries sustained by the employees are fractures of the metatarsal and metacarpal bones. By careful attention to proper reduction and maintenance of good position combined with physiotherapy from the time of reduction, the period of disability has been reduced fifty per cent. One can readily see the economic value of thousands of injured employees getting back to work in half the customary time.

It is hoped that this short discussion of this important phase of therapy will enable the reader to visualize its importance.

The American Association for the Advancement of Science.

DECEMBER the 27th the American Association for the Advancement of Science opened its jubilee session in Cincinnati in celebration of its 75th anniversary. Dr. Charles D. Wolcott, Secretary of the Smithsonian Institute, is the President for the coming year and Dr. Daniel T. MacDougal is Secretary.

Among the subjects announced for discussion were evolution in its relation to everyday life, the construction of the atom and the molecule, or rather their arrangement into definite patterns and shapes of crystals. This discovery was made possible by the x-ray spectroscope and not only the size and shape of the molecule is known, but changes in length can be detected and accurately followed. Another instrument was described by which changes one two-hundred-and-fifty-thousandth of an inch in a steel rod can be detected. Dr. Willis T. Whitney of the General Electric Company lectured upon the subject, "The Vacuum: There's Something in It." Interesting lectures upon other subjects were given, one upon geology and one upon engineering in particular attracted the attention of the lay public of Cincinnati and so many requests were received from them for admittance that finally the Association decided to issue a general invitation to the public to attend any lectures they might wish.

Of especial interest to physicists was the lecture by Dr. Bergen Davis, Professor of Physics at Columbia University, who discussed the refraction of x-rays in pyrites and the change of frequency and wave-length of the x-ray in elements other than carbon, also the refraction of the x-ray in calcite.

American College of Radiology and Physiotherapy.

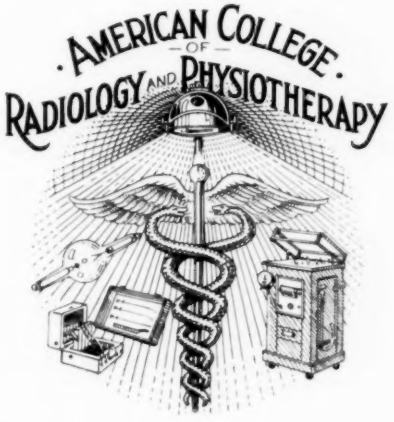
FROM the widespread and popular reception it has received, it is self-evident that the American College of Radiology and Physiotherapy meets the approval of the profession generally, and those interested in some one or more phases of the subject particularly. Although no intensive membership work is being done, applications from reputable men are coming in at a rate which if continued through the first year of the existence of the Collge will make it by far the largest organization of its kind in the world.

And it is especially gratifying that those seeking admission are men of high standing professionally and individually, are members of their local medical societies, and of the American Medical Association. Many also are members of the American College of Surgeons.

The inevitable conclusion is that the profession as a whole is now ready for one national inclusive organization covering all phases of x-ray, radium and physiotherapy, through which the standards of radiology may be elevated as rapidly as possible and the recognized benefits of this branch of medical science fully realized by its proper understanding and administration as an adjunct thereof.

These are the purposes of the College, and because of them, the College has been accorded prompt recognition by the American Medical Association. Coming unsought, as it did, this recognition affords the officers and founders of the College reason to congratulate themselves for having correctly diagnosed the desires of the profession generally, and in planning an organization which has been immediately accepted as the means of fulfilling those desires. That feeling of gratification is not lacking, however, in a very keen sense of the responsibility which the achievement of those purposes in keeping with the recognition thus granted entails on those administering the affairs of the College.

No doubt the years of close association in the work of the Nebraska State Medical Association which both Dr. Mullins and Dr. Fouts have given in the past have helped materially to bring the organization of the American College of Radiology and Physiotherapy to successful fruition. Dr. Mullins, it will be remembered, was president of the Nebraska State Medical Association in 1918, and Dr. Fouts has been a member of the Board of Councillors of the Nebraska State Medical Association for seventeen years. He has also been delegate to the American Medical Association for the years 1922 and 1923, and has been reelected for the year 1924.



As a means of familiarizing the profession with the insignia which the officers of the College have adopted, that insignia is here reproduced. A glance will indicate the broad purposes of the College in that the insignia embraces all phases of the science.

Those desiring to make application for membership in the College should address Dr. Roy W. Fouts, Secretary, 121 South 33rd St., Omaha, Nebraska, bearing in mind that membership in the local county medical society is a condition precedent to membership in the College.

Nobel Prize in Physics

DR. ROBERT ANDREWS MILLIKEN, winner of the Nobel Prize in Physics for 1923, is a native son of Illinois, a graduate of Oberlin College, a postgraduate of Columbia University and of various other universities both here and abroad. For a number of years he held the position of Director of the Department of Physics in the University of Chicago and is now Director of the Norman Bridge Laboratory of Physics and Chairman of the Administrative Council of the California Institute of Technology, Pasadena, California, having gone there in 1921 from the University of Chicago.

The Nobel Prize was awarded him particularly for his achievement in isolating the ion. He is noted besides for his work upon the polarization of light emitted by incandescent, solid, and liquid surfaces; the variation of dielectic constants with frequencies; the radioactivity of uranium min-

erals; the effect of temperature on the discharge of electricity from metals under the influence of ultraviolet light; charge of the negative ion in gases; photo-electric fatigue; absorption of x-rays; discharge potentials in high vacua and the velocities of electrons discharged from metals under the influence of ultraviolet light.

Announcement of the Nobel Prize in Medicine was noted in these columns lately and it is of additional interest regarding that to note that not only did Dr. Banting share his prize money with Dr. Best, but that Dr. McLeod has also shared his with Dr. J. B. McCollip of Alberta University. Both Dr. Banting and Dr. McLeod have expressed their regret that Dr. Best and Dr. McCollip were not officially recognized as joint discoverers with themselves.

Dental Series Begins.

ON THE first page of this issue appears the first article in the dental series, foreword of which was given in these columns in the November issue of the Journal. It should be remembered that Dr. Lurie, the author of this article, who is to contribute a number of articles to the Journal this year, has signified his willingness to answer any questions asked by those interested in this phase of the science of radiology. Questions are to be sent to the Journal office, 121 South Thirty-third Street, Omaha.

The American Congress of Internal Medicine.

WE TAKE pleasure in making the following announcement of the approaching meeting of this particular branch of the medical profession.

The Eighth Annual Clinical Session of The American Congress on Internal Medicine will be held in the amphitheatres, wards and laboratories of the various institutions concerned with medical teaching, at St. Louis, Mo., beginning Monday, February 18th, 1924.

Practitioners and laboratory workers interested in the progress of scientific, clinical and research medicine are invited to take advantage of the opportunities afforded by this session.

Address enquiries to Frank Smithies, Secretary-General, 1002 North Dearborn Street, Chicago.

ELSWORTH S. SMITH, *President, St. Louis.*

DEPARTMENT of TECHNIQUE

Protection in the Use of Ultra-Violet.

1. The black paper used in wrapping x-ray films is valuable as a protective material when using ultraviolet. An opening to get the area to be exposed can quickly be cut in the center of the paper with a pair of scissors. After use the paper is discarded, a new piece being used for each patient.

To those physicians who do not need to use the paper themselves, we might suggest giving it to the kindergarten. The little tots will make good use of it.

The heavy cardboard coming with x-ray films makes excellent material for book covers, which can be used for binding volumes of medical journals or turned over to a professional book binder.

2. Lead impregnated gloves worn for protection of operator from x-rays frequently leak and become worn out too soon. Someone has found that wearing a pair of ordinary cotton flannel gloves inside the rubber gloves absorbs the moisture from the hands and greatly prolongs the life of the lead rubber gloves.

3. X-ray films are much more easily slipped into the filing envelopes if the corners are clipped off as soon as removed from the metal holders. They are much less apt to scratch each other, too.

4. Discarded x-ray films from which the silver emulsion has been removed by washing in hot water make an excellent protective material for film holders during the examination of patients with discharging wounds or moist dressings.

We recently saw storm windows made from washed x-ray films mounted upon the window screens.

They are frequently used to repair broken celluloid windows in automobile curtains.

If you have x-ray films you wish to turn into cash, there is a ready market for them. The address of a purchaser will be found in the advertising pages of the Journal.

5. If one is equipped with a number perforator the lead backs on dental x-ray films make excellent plate markers. The date and number, together with the letters L and R are stenciled in the lead. The letter not needed for the particular patient is clipped off with scissors, after which the marker is placed on the film to be exposed. A number of such markers can be prepared in the morning ready for the day's work. After use the marker is discarded, a new one being taken for each patient.

6. Where one prefers to use lead numbers and letters a small piece of adhesive plaster can be used to support the numbers. Each morning the appropriate date is placed along the upper margin, while the number to be used is placed below the date. When the patient comes in, a letter appropriate to the patient is added. This will be found a very convenient method of marking films.

7. The following motto framed and hung in a conspicuous place in the office has been helpful in checking requests by patients for "pictures" and "prints."

> "Patients are sent here for consultation and diagnosis and are not entitled to x-ray plates or films. Prints in the hands of patients lead to false interpretations, confusing opinions, multiplicity of advice and bad results."

The above motto printed on white card of a size suitable for framing and hanging in the office can be had by addressing the Radiological Publishing Co., 121 S. 33rd St., Omaha, Nebraska. Enclose 50 cents in postage with the request.

ABSTRACTS and REVIEWS

Acute Bone Atrophy and Its Roentgen Picture. Chr. I. Baastrup, M.D., Acta Radiologica, 2:364-409, September, 1923.

THIS is abstracted from the above address delivered in Stockholm last June, at the Congress of the Northern Association for Medical Radiology.

In a roentgenological sense "bone atrophy" denotes a pathological change in the bones, a change manifesting a reduced density when pictured in the roentgen plate, the reduced density being due to a lessened lime content of the bones.

A distinction is made between "acute bone atrophy" and "osteoporosis" and "halisteresis." The latter two terms are not synonymous with the term "acute bone atrophy." "Osteoporosis signifies a pathological process which is found in a number of diseases of the bones, among which is the acute bone atrophy; halisteresis is the denomination of a change in substance found in several diseases of the bones, among which is *possibly* also acute bone atrophy." The term "ostitis rarefícans" also used as an expression for the diseases mentioned in this article, is not regarded as apt as there is no reason to regard these changes as inflammatory.

To obtain a distinct nomenclature the author proposes that the term "bone atrophy" should be used to denote a diminution in the size of the bones, which as commonly used it does not denote, and that the term "bone degeneration" or "lipomacia" be used to denote degenerative changes in the substance of the bones. The term "rarefaction" he would use to denote bone degeneration "in a roentgenological meaning."

Basing his conclusion upon animal experimentation he states that diminution of the bones always takes place in connection with severe lesions of the extremities, no matter of what nature, but this diminution cannot be recognized in the x-ray plate if very small. A rarefaction of about ten per cent in rabbit's bone is as a rule recognizable in the x-ray plate. The spotted stage he believes is recognizable only in high degrees of rarefaction, though it appears fairly soon after the causal factor and disappears in the course of a few weeks or months, although he has found it one year after the lesion had taken place. Also he found that rarefaction from lesions and from inactivity gave the same roentgenological picture, but "inactivity is the essential factor in all varieties of the condition hitherto known as acute bone atrophy."

Radium Treatment of Toxic Goiter With Metabolic Deductions. R. E. Loucks, M.D., C.M., Am. J. Roentgenol., 10:767-776, October, 1923.

THE ANATOMY, function and normal metabolism of the gland are first discussed, then the signs and symptoms of exophthalmic goiter, the technique of radium treatment and then case reports are given.

The writer says that after seven years of experience, the last three of which have been under the most exacting scrutiny, he has concluded that toxic goiter is not a surgical disease, but can be cured by radium. Of 180 cases treated by him only ten received a second radiation. Some cases will be free from symptoms after six months, though others of long standing will take from one year to eighteen months to show a normal metabolic rate and normal heart action.

Conclusions as to metabolic rate are: "(1) A high systolic and a low diastolic blood pressure show a normally balanced pulse pressure in some cases before the metabolic rate becomes normal. (2) Three months after treatment the metabolic rate was found to be normal in many cases that had been active. (3) A high systolic blood pressure in the late stages of a toxic adenoma is conclusive evidence of myocardial or renal degeneration whenever it is not reduced 20 to 30 per cent after the normal metabolic rate has been re-established. (4) The basal metabolic rate proves and estimates the degree of thyroid activity and also furnishes conclusive evidence of toxic control after radium therapy."

Exophthalmic Goiter and Other Forms of Hyperthyroidism. George R. Murray, M.D., F.R.C.P., Victoria University of Manchester. Lancet, 205:293-295, August 11, 1923.

DIAGNOSIS, prognosis, general management, diet, medical treatment, radiological and electrical treatment, surgical treatment and possible complications of the disease are discussed.

Of the radiological and electrical treatment the author says: "A prolonged course of treatment by x-rays or radium in skilled hands is one of the most reliable means we possess of controlling the activity of the thyroid gland and hastening its return to a normal condition in many cases. When x-ray treatment is available, a dose of one and one-half Sabouraud units, measured before filtration and passed through a layer of 3 mm. of aluminum and boiler felt placed on the skin, may be given twice a week. Later on this dose may be given at lengthening intervals, according to the progress made. Larger doses may be given at longer intervals, the object being to give as large a dose as possible without injury to the skin. This treatment finds its most favorable opportunity in cases of simple hyperthyroidism and in the milder cases of Graves' disease. It is also of value in severe cases. In cases of Graves' disease in which the goiter is unusually large and in cases of toxic adenoma, the results are unsatisfactory, and if a subsequent operation becomes necessary, the capsular adehesions render it more difficult. For patients who live at a distance radium is more convenient, as the plates have only to be applied for twenty-four hours once every six weeks. A radiotherapeutic course requires six months, a year, or even two years to produce its full effect. Radium is unsuitable for acute cases of exophthalmic goiter, as the initial increase of secretion may prove fatal. When radiotherapeutical treatment is not available a mild interrupted current may be applied by means of electrodes placed over the goiter and at the back of the neck for an hour twice a day."

As to surgical treatment he does not advise it in simple hyperthyroidism and in mild cases of Graves' disease. In cases of toxic adenoma of the thyroid and in cases in which there are present signs of pressure on the trachea, or upon the recurrent laryngeal nerves, operation is advised. Selection of suitable cases of Graves' disease is difficult. If after six months of medical treatment there has been no improvement, or in cases in which the goiter is unusually large, he would operate by

ligation of the thyroid vessels or by partial removal of the goiter. Physical condition, social position and patient's wishes govern in other cases. The operative mortality in these cases is from three to five per cent, even with all possible care.

Roentgen Ray Treatment of the Thyroid. E. L. Jenkinson, M.D., Am. J. Roentgenol., 10:814-817, Oct., 1923.

COLLOID, cystic and simple thyroids should not be subjected to radiation. Routine treatment of all cases is not satisfactory and every case should be treated as an entity.

The metabolic rate must be frequently determined, as it is an indispensable guide in thyroid therapy.

Most cases of hyperthyroidism and exophthalmic goiter will respond to x-ray therapy.

X-Ray Treatment of Lesions of the Thyroid Gland. John G. Williams, M.D., Long Island M. J., 17:353-359, September, 1923.

GOITERS are classified as (1) simple, cystic, colloidal; (2) adenoma; (3) exophthalmic; (4) malignant. Adenomata with hyperthyroid symptoms, exophthalmics and malignant goiters are suitable for x-ray therapy. Rest and freedom from worry and excitement, together with medical treatment are essential concomitants of x-ray therapy. Cases not completely cured are better surgical risks after this form of treatment. Surgery is indicated in malignant disease of the thyroid whenever complete removal of the growth is possible and if inoperable the case should be treated by x-ray as this will probably relieve the symptoms and may possibly cure the disease. If symptoms persist other surgery than x-ray therapy should be used.

The Value of An X-Ray Examination in Pulmonary Disease. W. S. Larrabee, M.D., Southwestern Med., 7:376-379, Oct., 1923.

EVERY lung examination should consist of a screen examination supplemented by films, as each has its special advantage. Stereoscopic films are preferable to the ordinary single film and if made with modern apparatus and good technique will be free from blurring.

In the normal lungs practically no shadow at all will be found in the apices or the peripheral areas, but as the hilum is approached shadows appear and increase in size and density as the mediastinum is approached. This is due to blood vessels, lymphatics and bronchial structures. "The normal diaphragm presents a smooth, sharply defined, rounded outline, with the convexity directed upwards into the lung fields, the left being at a lower level than the one on the right. Normally, the costo-phrenic angles are very clear and are easily demonstrated on forced inspiration. * * * In cases of pulmonary disease, also, the x-ray enables the examiner when properly skilled in interpretation, to detect infiltration cavities, enlarged, caseated and calcified glands, periobronchial thickening, bronchiectasis, abscesses, fibrosis, pneumothorax and fluid in the pleural sac, whether free or encapsulated. The location and extent of these lesions may be defined by the x-ray with a certainty and rapidity beyond the power of the physical examination to approach." However, the x-ray is not all sufficient in diagnosis and must be taken in connection with physical signs and older methods should not be lost sight of.

Changes from the normal "may range from a transparency indicating presence of air to a density signifying a more or less solid mass, in the shadow of which all lung structures may be obliterated. These findings named, and many more found in this procedure of examination, are hard to differentiate and clinical findings and history should always be taken into consideration . . . . . "

Regarding incipient tuberculosis, opinions differ as to definition of incipiency. "When shadows are found which represent tuberculous pulmonary involvement the case is no longer an incipient one, even though the clinical aspect indicates it to be so. At times the only sign of incipient tuberculosis will be a lame diaphragm on the affected side or the hili may be noted to be very slightly increased or the peribronchial shadows have a woolly outline, and are more in evidence than normal; or one apex fails to light up as well as the other. There may be a slight increase of shadows on one side of the lung over the other, which is seen to involve the peripheral areas or the small, finer, branching shadows may extend upwards into the apices."

Certain Biological Principles of Radiation Therapy. Sanford Withers, M.D., Am. J. Roentgenol., 10:776-781, Oct., 1923.

CONCLUSIONS: The cellular reaction depends upon the amount of radiant energy absorbed, whether primary or secondary in origin.

Susceptibility to short wave-length therapy is a cellular characteristic depending upon a definite histological structure.

The normal tissue reaction to radiation and neoplastic invasion depends to a large degree upon the well being of the body as a whole.

There is sufficient data extant to predicate on *a priori* grounds those tissues or tumors which will prove radioresistant or radio-susceptible.

The use of radium or x-rays is just as radical and rational a procedure as the use of other physical agents in treatment of neoplastic conditions.

The use of radium or x-rays in a given condition should require also an equal amount of surgical judgment, a more complete knowledge of the pathology present and a broader biophysical training than the corresponding surgical treatment demands.

Recent Developments in Radium Therapy. Frank Edward Simpson, M.D., Illinois M. J., 44:327-329, Nov., 1923.

RADIUM emanation is a term which should be applied to the gas emanating from radium and not to the rays. This gas is the first decay product of radium and is superior to radium itself as a therapeutic agent, for there is no danger of losing the radium and a large dose may be concentrated in a small tube. When enclosed in glass ampules it can be used within the tumor tissue and is much superior to steel needles filled with radium salts so used, since traumatism is minimized by these glass ampules and the softer beta rays, having to penetrate only the glass walls of the ampule, are effective in bombarding the cancer cells, also dosage is exact. Not more than one-half to one millicurie of emanation should be used per ampule.

On the other hand, in surface or distance radiations large quantities of radium are advisable and necessary for the best results. At least 1,000 milligrams of radium element or millicuries of emanation are necessary for the best effects. Too small a quantity, insufficient equipment and incorrect technique have led to many failures in radiotherapy.

Except in certain conditions, the author takes exception to Bumm's dictum that radium has not an efficient sphere of action at a greater distance than three centimeters.

Radium rays are four times as penetrating to body tissues as are x-rays and the problem of screening them off is a difficult one, for they are thirty times more penetrating to metals than are x-rays. The author uses a specially contrived apparatus for screening, which he describes.

Most radium therapists have agreed that operable growths should be

operated upon, but Quick has recently declared that radium is the method of choice in primary carcinoma of the tongue, lip and cheek.

The British Empire Cancer Campaign. World's Health (Red Cross), 4:12-14, September, 1923.

THERE has been established within the British Empire a Grand Council to act as a clearing house for cancer research. The members of the Council will act as chiefs of its various division of medicine, surgery, human pathology, chemistry, physics, radiology, animal and vegetable pathology, hygiene and statistics. The Council will by all means in its power aid all research workers, whether individuals or groups of workers and will draw up appeals to individuals, communities and the state in the way of educational propaganda.

The promoters of this movement appealed to the Red Cross for aid and the Council is now sponsored by that organization.

Roentgen Ray Intoxication. Roentgenotherapy in Man in the Light of Experiments Showing Sensitivity of Intestinal Epithelium. S. L. Warren, M.D., and G. H. Whipple, M.D., Jour. A.M.A., 81:1673-1675, Nov. 17, 1923.

THE AUTHORS review their previous publications upon this subject as well as those of other writers and their conclusions are that both animal experimentation and clinical observation render proof that the human intestinal mucosa is peculiarly sensitive to the hard and short wave-length roentgen rays and that a similar condition exists in the common laboratory mammals. The intestinal epithelium is at least as sensitive as the skin and is probably more so, considering the increased distance from the target and the intervening body tissues.

Erythema doses or larger doses given over the abdomen or the intestinal areas may cause injury to the intestinal epithelium and when giving cross-fire treatments over areas including intestinal coils the loops may be seriously injured. This injury may not result in severe clinical intoxication, but it may cause ulcers that are no less chronic and dangerous than roentgen ray skin burns.

Any radiologist who contemplates radiotherapy of abdominal areas should remember these facts and all cases so treated should be carefully studied and reported so that knowledge of danger limits may become comprehensive.

Local Resistance to Spontaneous Mouse Cancer Induced by X-Rays. James B. Murphy, M.D., Joseph Maisin, M.D., and Ernest Sturm, J. Exper. Med., 38:645-653, Nov., 1923.

THE AUTHORS found that "autografts from spontaneous cancers of mice when replanted into areas previously exposed to an erythema dose of x-rays failed to grow in the majority of instances (71.4 per cent), while similar grafts inoculated into untreated areas grew in a large proportion of the animals (83.6 per cent).

"Autografts of spontaneous cancer, established and growing in the skin, disappeared in 76 per cent of animals after the tumor and surrounding tissues had been exposed to an erythema dose of x-rays, whereas other autografts of similar derivation that had been given a like dose of x-rays outside of the body and had been implanted in the same animals grew progressively in 96 per cent of instances. That this result was not due to a greater susceptibility of the cancer cells x-rayed in situ was shown by the fact that tumors treated in situ with x-rays and then replanted in an unrayed location on the same animal grew actively. Evidently the ray had done no direct damage to the cancer cells."

Primary and Secondary Resistance to the Induction of Cancer. J. A. Murray, M.D., B.Sc., Director Imperial Cancer Research Fund, Edinborough. Lancet, 205:159-163, July 28, 1923.

IT HAS been shown by experimental carcinogenesis that a continuation of effective stimulation over a considerable period of time is essential to the successful induction of cancer, and in cancers arising from the application of tar or its products no characters, either clinical or microscopic, distinguish it from cancer of the same tissue arising from other irritants or arising spontaneously.

The conclusions in this study are based upon the study of experimentally produced (tar) cancer. The length of time which arises from the beginning of tarring until autonomous growth sets in varies from three months to eighteen months, but most mice will develop skin cancer within six to nine months.

To find whether there was an upper limit to the intensity of stimulation followed by cancer production, bi-weekly applications of ethereal extract of tar were made to a small area on the nape of the neck of rabbits and within a month thereafter highly inflamed and painful excoriations occurred. Applications were discontinued for from two to three weeks and then were made weekly when the irritative phenomena did not reappear. Within six to eight months two of the fifteen rabbits showed localized progressive lesions which continued after the painting was stopped and which proved to be typical squamous cell carcinomata.

The author remarks in this connection that cancer is never observed in workers in chromic acid factories although ulcerations are very common. X-ray cancer rarely supervenes at the site of the x-ray burn, and never upon that of radium burns, but comes in areas repeatedly subjected to slight amounts of irradiation. Again, while engine drivers develop cancer in the areas subjected to irradiation from an open fire box, cancer never develops in the fingertips of smokers who habitually press down the glowing tobacco with the finger.

According to Deelman the association of another kind of injury with tarring results in a shortening of the time necessary for cancer to develop. It seems to him that the reparative changes following trauma must put the cells in a more receptive condition for carcinogenetic action of the tar.

Drew concludes from his work on tissue culture that malignant growths continuously produce growth stimulating substances which normal tissues elaborate only in response to cell damage. A direct relation was found to exist between the growth stimulating power of tumor extracts and the rate of growth of the tumor used to prepare it. A certain amount of this activating substance is probably produced by any damage to the cells and constant repetition makes production automatic and continuous after the removal of the cause of protoplastic disintegration.

The conclusion as to the secondary character of neoplastic transformation is further supplied by the discrete focal character of the process of tar induced growths, for growth does not begin throughout the whole zone of tar application, but in isolated minute areas. Secondly, there exists in these experiments a latent period which is very little affected by continuation of the irritant.

When several substances of different carcinogenetic strengths are applied simultaneously to separate areas of skin there is no certainty as to the results. The weaker whole tar may inhibit for a time the development of the tumor produced by the more active ethereal extract. There are "indications of a mutual influence of approximately contemporaneous tumors, by which their full cancerous development is retarded for a time or permanently. The other experiments show that the induction of a fresh primary growth after a first has been definitely established meets with very intense resistance, whether the first tumor be of the same parent tissue or another. The nature of this secondary refractoriness is unsure. * * * Nor

has it anything in common with the well known acquired resistance to the growth of transplantable tumors. * * * Its greatest interest and importance, however, lies in the indication it gives of a systemic, constitutional change in the organism in which cancer has developed, a change which if it could be recognized with certainty and rapidity, would enable us to recognize cancer in its earliest stages, and could we produce it without initiating new growth, would place in our hands a rational means of prevention."

Further Research on the Relation of Carcinoma to Infection. W. M. Ford Robertson, M.D., Lancet, 205:330-333, Aug. 18, 1923.

DR. W. FORD ROBERTSON, the author's father, in 1921 recorded his observation of certain rods observed within cancer cells. These were anaerobic bacilli of the diphtheroid group, and evidence was brought forth to show that the continued proliferation of epithelial cells was due to action of these bacteria. In support of his conclusions he quoted the results of microscopic study of the cells, artificial cultivation of the bacteria, experimental cultivation of cancer in mice, either by means of pure cultures of the bacilli or together with a culture of staphylococcus from human cases, and by focal reaction and therapeutic immunization in which the neoplasms decreased in size and pain and discomfort were allayed. Further experimental work has been carried on by the author himself and is presented in this paper to corroborate his father's researches. The results of the researches are to be presented at a later date.

Experimental Inquiry Into the Causes of Cancer. Archibald Leitch, M.D., Director of Cancer Hospital Research Institute. British M. J., 2:1-7, July 7, 1923.

THIS is a brief review of the research upon cancer etiology. Fibiger's researches are especially discussed. The known facts regarding tar cancer, paraffin cancer, arsenic cancer, tobacco cancer, analine cancer, x-ray and radium cancer are all reviewed.

The author says that looking backward we often wonder why certain great discoveries were so long delayed when all the data had long been at hand from which to draw conclusions. We fail to appreciate the difficulties of the pioneer, in any field, and some future generation will wonder at our flounderings, contentions and guesswork regarding cancer etiology and treatment.

Clinical Problems in Roentgen Therapy of Deep-Seated Malignancy. Chas. L. Martin, M.D., and J. M. Martin, M.D., Am. J. Roentgenol., 10:818-830, October, 1923.

WHEN complete cure is out of the question treatment should be planned to give symptomatic relief. To use a routine method for the diagnosis sent in is not conducive to the best results and yet this is the practice of many men. A careful history and a searching physical examination should be made of each patient. If the roentgenologists who delegate this to a clinician because they feel that they themselves are not qualified to make such an examination would "take up the study of the clinical course of malignant tumors and add the information gained to their extensive knowledge of the roentgenographic appearance of malignancy in the chest, bones, stomach, colon, kidneys, etc., they would be much better prepared to examine cases of malignancy than the average clinical man who considers cancer as only one of the branches of his work." The roentgenologist should not confine his study to the field of pure physics, but should include gross pathology and biological reactions in his curriculum, for "after all we are treating living patients and not tanks of water having a depth of so many centimeters."

Two things should be considered before the matter of depth dose is touched upon, first the sensitiveness of the normal structures to be rayed and second the nature and distribution of the malignant cells to be attacked. Although the knowledge upon these two points is chaotic there are available data of practical value which should be utilized.

The article is illustrated by excellent charts which give the possible paths of metastases from carcinoma of the prostate, stomach, pancreas, testis, larynx, ovary, uterus, cervix and the breast. These possibilities are all discussed. The article is packed with valuable suggestions.

"Carefully written records containing repeated physical examinations will eventually establish the true value of our recent progress in x-ray physics as applied to the patient."

Roentgen Ray Measurements. L. Baumeister, Engineer at Erlangen. Acta Radiologica, 2:418-429, September, 1923.

THIS is a lecture which was delivered at the invitation of Professor Forssell before the Swedish Society for Medical Radiology.

The author discusses his subject under the heads of (a) distribution of intensity of rays in the irradiated body; (b) the supplementary dose of stray x-rays; (c) the influence of the depth dose.

Illustrated diagrams are given to show how, in the measurement of dosage, errors occur due to the difference between the length of the path of the central ray and the path of the ray at the edge of the port of entry. On account of this diminution of intensity of the rays at the edge of the field it is better to use smaller medium sized ports of entry and he advises the use of compressor tubes to reach a more uniform intensity of the rays applied.

There are a number of small details influencing the dose which organs may receive in the depth in spite of the same unit skin dose being applied in every case. The correctness of the calculated dose depends upon the accuracy and attention with which these details are worked out, and it also depends upon the secondary rays generated in surrounding tissues.

Medical Education Fifty Years Ago. E. H. Bradford, M.D., Boston M. & S. J., 189:748-762, Nov. 15, 1923.

THIS is a very interesting paper, which revives some of the great figures of the medical world of half a century ago. Personal touches are given the portrait of Oliver Wendell Holmes and those of other men of that time. The author says that the "medical teacher today has still much to learn from his predecessors and, distinguished as are the scientists of today, it is well to remember that there were great men before the time of Agamemnon."

The Pitfalls of the X-Ray. John Henzies, D.D.S., Dental Facts, 11:73-75, Nov., 1923.

THIS topic was assigned the writer, but he says he would prefer to call his paper the "pitfalls of interpretation."

He quotes from Raper, who names the most common mistakes as (1) mistaking the antrum for a large abscess cavity over the molars and bicuspids; (2) mistaking the mental foramen for an abscess under the lower bicuspids; (3) mistaking the coronoid process for a third molar; (4) mistaking the anterior palatine foramen for an abscess over the central incisors; (5) mistaking a small buccal filling in a molar for a pulp stone. An interpreter with a knowledge of anatomy, histology and pathology and who uses his brains to make a careful examination, and charts the findings with a preliminary diagnosis is quite unlikely to make any of these mistakes. A tentative diagnosis is necessary if one would derive the greatest benefit from a radiograph, which is only a link in the chain of

diagnosis. Snap diagnoses are the ones which lead to trouble. To attempt diagnosis without the aid of a radiogram is to court trouble. The author cites two cases where this was true. In one, four upper anterior teeth had porcelain crowns (made two weeks previously) and a cyst was present from the median line extending out and into the antrum. In another case the patient insisted she had pyorrhea although the dentist could find no clinical evidence. The patient insisted upon an x-ray being taken and all teeth were found to have pyorrea.

Checking up on root canal operations is one of the most useful functions of the x-ray in dentistry.

What Should a Dental Radiogram Possessing Diagnostic Value Show? Henry Cline Fixott, D.M.D.

THIS article from the Northwest Journal of Dentistry is quoted in "Service Suggestions" as follows:

"What should a dental radiogram possessing diagnostic value show?

1. The alveolar process.
2. The walls of the alveolus.
3. The peridental membrane.
4. The cementum.
5. The dentine.
6. The pulp.
7. The enamel.
8. The gums and soft tissues.
9. The black area of a film that has been exposed to the direct x-rays.

"It should show the roots and the crown of the teeth clearly and all of the tissues surrounding the roots of the teeth, without shadows and with as little distortion as possible.

"Let me describe briefly these various tissues and their radiographic appearance:

"First. Continuous with and forming part of the maxilla and the mandible is the projection of bone that grows up around the roots of the teeth and forms the sockets, in which the roots of the teeth are held by their membrane. This is called the alveolar process. For convenience we will refer to the bone surrounding the roots of the teeth and extending over and beyond their apices as

THE ALVEOLAR PROCESS

"The alveolar process is shown in a radiogram as a spongy cancellated network of bone entirely surrounding the tooth. Normal alveolar process shows a cancellated structure with definite, clean cut, but with quite irregular lines. This structure is invariably affected by pathological conditions. An increase or decrease in the density of this structure, shown by radiopaque or radiolucent areas, is an indication of pathology.

THE WALL OF THE ALVEOLUS

"The wall or lining of the alveolus is shown in a good radiogram as a thin white line called by different authorities the peridental lamellae, the stratum durum or lamina dura. A break in this line or the entire absence of it is indicative of pathology, due to trauma or infection.

"Between the root of a tooth and the lining of the alveolus there is shown in a good radiogram a thin black line.

THE PERIDENTAL MEMBRANE

"Trauma or infection may cause a thickening of this membrane either at the expense of the lining of the alveolus or the cementum of the tooth root. In some cases the continuity of this line is definitely broken. Any definite irregularity indicates pathology, and should be thoroughly investigated.

THE CEMENTUM

"Pericemental irritation and infection is shown by a roughening or irregularity in the outline of the tooth root.

"Hypercementosis is shown by an enlargement of the root. This enlargement is apparent at the point of irritation, usually about the apical third of the root.

THE DENTINE

"Secondary deposits of dentine along the walls of the pulp chamber are caused frequently by traumatic, thermal or other irritation or infection of the pulp. These deposits are apparent in a radiogram by a narrowing of the pulp canal and in increased radiopacity of the pulp.

THE PULP

The normal pulp is shown in the radiogram as a dark radioparent mass, filling the pulp chamber and roots of a tooth and finding an outlet or outlets at the apex of the root. An increase in the radioparency of the pulp is indicative of an acute pathology. An increase in radiopacity indicates a chronic condition such as pulp stones, secondary deposits of dentine along the walls of the pulp chamber, etc.

THE ENAMEL

"The enamel covering the crown of a tooth is more dense, consequently more radiopaque than the dentine or cementum.

"Caries is shown by an increased radiolucency of the parts affected. A dark area extending from the contact point or any exposed surface of a tooth through the enamel and into the dentine is caries or is caused by cavity preparation, etc.

THE GUMS, ETC.

"The gums and soft tissues surrounding the teeth are shown as radiolucent or dark areas. In a good radiogram these tissues should show as slightly less radiolucent than any part of a film that has been exposed to the direct x-rays."

Idiopathic Menorrhagia and X-Ray Therapy. E. L. Stewart, M.B., and H. M. Tovell, M.D., Canad. M. J., 13:745-746, Oct., 1923.

THE material upon which this paper is based was taken from 100 cases of menorrhagia treated by the author. The number of idiopathic cases is not stated, but only a portion of the 100 were such, the others were associated with fibromata. If idiopathic hemorrhage occurs just at puberty or soon after, one should be cautious about the use of the x-ray, although if minor operative measures and local treatment fail to bring about a cure and it is a choice of hysterectomy or radiation the author would use radiation. One cannot promise in such cases that the menses will not cease, for they may cease after even only a partial dose. In such cases the thyroid should also be looked after, as often there is pathology of that organ which x-ray treatment will cure and the hemorrhage will disappear without further treatment.

Cases occurring during the child bearing period should have a curettement first and if this measure fails then there is left the choice between hysterectomy and x-ray treatment. The author prefers the latter treatment. In cases at the menopause or near to it he would use the x-ray whenever not contra-indicated.

Results from the author's treatment of idiopathic hemorrhage have been excellent. The ages of patients treated were from 35 to 55 and only one of these cases required more than two courses of treatment.

In cases complicated with fibromata the menorrhagia was controlled after the second course of treatment, but it took from four to six courses for reduction of the tumor. The danger of the fibroid tumor undergoing sarcomatous transformation is regarded as possible but doubtful. Neither Ewing nor Bland-Sutton believe it to be anything but a rare occurrence. However, diagnostic curettage should be performed lest the bleeding mask an early malignancy.

A Study of the Action of Measured Radiation Doses on Carcinomata of the Uterine Cervix. Henry Schmitz, M.D., F.A.C.S., Am. J. Roentgenol., 10:781-789, Oct., 1923.

CERVICAL carcinoma is either of the unripe basal-cell type, the squamous-cell type or the cylindrical-cell adenocarcinoma. The radiation sensibility of these three types differs and is greatest in the immature basal-cell type and least in the squamous-cell carcinoma.

Prognosis in radiation therapy of these lesions must be based upon four

things: the measured radiation dose, changes occurring in the blood (particularly the nitrogen constituents and the behavior of the white blood corpuscles), a careful clinical examination to determine local healing and repeated microscopic examinations before and after treatment.

Sufficient time has not elapsed for end-results of the work reported in this paper to be definitely known, but these will be published later. Tentative deductions from the work done are that the lethal carcinoma dose for unripe basal-cell cancers is about 100 per cent erythema skin dose; for adenocarcinomata about 130 per cent and for squamous-cell 150 to 170 per cent.

Radiography of the Fetus in Utero. T. I. Candy, M.B., D.M.R.E., Arch. Radiol. & Electroth., 28: 146-153, Oct., 1923.

IN ANY CASE after the sixth month a clearly defined x-ray picture of the fetus can be secured and it is not impossible to secure a clear picture earlier than six months. In the later months, of course, the value of the picture lies in the information obtained regarding position, etc. The author has never found that there were any bad effects upon either mother or child, though, of course, one must use judgment as to number of exposures.

His technique is to have the patient lie face downward upon the Potter-Bucky diaphragm, with trochanters about an inch or so above the lower edge of the film in the cassette. The chest is raised on pillows, thus making the position a comfortable one. Sandbags are placed upon the backs of the thighs and to prevent movement of the fetus a strong cloth compression band measuring 42 by 12 inches, not unlike an obstetrical band, is manipulated by a lever-like arrangement which secures compression at the moment of taking the exposure. The anticathode of the overhead tube is centered over the third lumbar vertebra at a distance of 30 inches from a 15 by 12 duplitized film. The patient is asked to hold her breath and to press the abdomen firmly down upon the Potter-Bucky diaphragm, the compression is applied by an assistant and the exposure is made for five seconds using 25 to 30 ma. with a five and one-half inch spark gap. A 10 kva. transformer (X-Rays, Ltd.) and a fine focus Coolidge tube were used in all cases. A higher milliamperage did not work out well, because the sudden blast of milliamperage caused a temporary tremor of the patient. A good 16 inch coil giving 15 to 20 ma. for five or six seconds ought also to give a satisfactory result.

Development is very important and should be by time and standard temperature. Over-exposure will ruin the brilliancy and contrast necessary in these pictures. Under-development is the most common cause of failure.

Treatment of Severe Uterine Hemorrhage by Radium. Sidney Forsdike, M.D., F.R.C.S., British M. J., 2: 409, 411, Sept. 8, 1923.

BOURNE and Wilson are to be thanked for determining the etiology of one fraction of the cases of idiopathic uterine bleeding, namely those due to thyroid disorder. The author says the thyroid can account for only a fraction of cases, however.

The present paper deals with only severe cases of idiopathic hemorrhage in which all means tried had failed, and where some form of operation had been tried, 65 cases in all.

If a fibroid tumor calls for any treatment it calls for surgical treatment, either myomectomy or hysterectomy, and radiation should only be used in such cases to check the hemorrhage and prepare the patient for surgery. If severe hemorrhage is the chief symptom and the fibroid tumor is small then the author would use radium.

All the author's patients were subjected to a preliminary exploratory curettage and whenever radium was used it was used in utero and not in the vagina, nor is radiation through the abdominal wall advised.

The author believes that radium arrests uterine hemorrhage solely through its action on the endometrium.

Fifty Cases of Carcinoma of the Cervix Treated with Radium. Malcolm Donaldson, F.R.C.S., England, *and* R. G. Canti, M.D., Cantab. (St. Bartholomew's Hospital). British M. J., 2:12-16, July 7, 1923.

THE RADIUM available consisted of two platinum tubes with walls 0.5 mm. thick. The tubes contained 53.1 and 54.2 mg. radium element and the outside of tubes measured 4 mm. in diameter and 34.8 in length. Also 13 platinum needles with walls 0.4 mm. thick were used. Each contained on the average 5.1 mg. radium element, the average outside dimensions being 1.8 mm. diameter and 23.5 mm. length. Measurements were corrected for platinum containers. The tubes were filtered with aluminum and placed end to end in the cervical canal and the needles were inserted into the cervical tissue at some distance from the canal and encircling it. In one series of cases the quantity of radium element varied between 133.3 mg. radium element and 173.6 mg., exposure being for eight hours. In the other series the amount of radium element was 173.6 mg. and duration of exposure was twenty-four hours. Sterilization of radium and filters was by boiling, soda not used.

Conclusions (clinical): Majority of patients cease to have hemorrhage, vaginal discharge and ulceration after radium treatment. In many inoperable cases life and usefulness is prolonged. Furthermore, in the operable cases preliminary application of radium will cause the disappearance of fungating growths or ulcers, thereby diminishing the risk of infection and of implanting new growth from the cervix during operation. The application of 173.6 mg. radium element for twenty-four hours is more efficient in bringing about this result than is the same amount applied eight hours upon three different occasions. The authors say that "since histological evidence of the efficacy of Dael's method of irradiation of the pelvic glands is impracticable its value is still *sub judice*, as it depends upon clinical evidence."

Conclusions (histological): The application of 173.6 mg. radium element for twenty-four hours causes a complete disappearance of the growth from the cervix within a few weeks, but the same quantity for eight hours produces little or no effect. Definite series of changes in the carcinoma cells can be demonstrated after irradiation leading up to destruction of the cell. Little or no effect is produced in the iliac glands when the cervix is irradiated. Changes in the malignant cells take place before the formation of fibrous tissue and so the latter is not the causal agent in the disappearance of the growth. Carcinoma cells are more vulnerable than is the uterine musculature. In the latter, local atrophy takes place at a later date.

The Diagnostic Value of the X-Ray in Obstetrics. Alexander M. Campbell, M.D., F.A.C.S., *and* Paul Winter Willitis, M. D., J. Michigan M. Soc., 22:465-469, November, 1923.

THE AUTHORS regard the x-ray as a valuable diagnostic aid in obstetrics, its chief value at present being in the detection of abnormalities of the fetus. Five of the leading roentgenologists of the country were consulted as to the danger to the fetus from diagnostic irradiation and all agreed with the authors that with proper technique there is no danger. However, too frequent repetition of the process is not advised.

The authors urge greater colloboration between the obstetrician and the roentgenologist and they believe that the possibilities for future development are very interesting. They believe that it

will become possible to visualize the various stages of labor and that various manipulations incident to labor may in the future be done under the fluoroscope.

Recurrences in Cancers of the Breast. John E. Summers, M.D., Jour. A. M. A., 81:873-875, Sept. 15, 1923.

THE AUTHOR says that in the case of a clearly operable cancer of the breast which recurs locally, either the technique of the previous operation was incomplete or else lymphatic extension had passed beyond the field of operation. Those who believe in Handley's theory of permeation of the routes of lymphatic dissemination believe that the future will show a lowered rate of local recurrence in cancer of the breast and lowered percentage of invasion of the cavities of the body. Likewise, they will see the value of irradiation. They will employ "a wider fascial removal and a more systematic employment of irradiation in a circumferential manner, in a wide extension along the route of the lymphatics draining the area of the breast in which the tumor was located."

Further, he says: "Irradiation of cancer in accessible locations, if a sufficient dose is given results in a destruction of the pathologic cells and their replacement by fibrosis; it also results in hyalinization, both conditions inhibitive of the extension of cancer; hence, the employment of irradiation before operation and as a postoperative measure is rational."

The author believes that the inheritability of cancer is undoubtedly the greatest factor in its etiology, but this does not exclude the factor of germ infection. "That cancer growth and metastasis do not follow the laws of bacteriologic infections is no reason that it may not have its own law, as have others which we acknowledge, but as yet cannot identify."

In conclusion, he says: "The day is coming when a cure for cancer will be discovered. It seems that this will happen only when we give up our present theories of its pathology, absolutely hopeless to date, become better students of biology and chemistry, and further seek the problem in a more rational analysis of its relation to the germ theory of disease."

Observations on Radium Dermatitis. M. Sydney Thomsen, M.D., *and* Cecil P. G. Wakeley, F.R.C.S., Arch. Radiol. & Electroth., 28: 153-158, Oct., 1923.

THE CLINICAL pictures produced by excessive exposure to x-rays and to radium are indistinguishable. Histologically the same is true except for the subungual hyperkeratosis seen in x-ray dermatitis. The author calls attention to the fact, however, that radium and x-ray dermatitis is only a more extreme form of the pathology produced by the sun's rays. "Many a sailor bears on his hands and face a thin atrophic pigmented skin, which is clinically indistinguishable from radium dermatitis, and especially so in that warty hyperkeratoses and telean.giectases are present." In countries where the topee is worn to protect the head from the sun's rays the condition appears only upon the hands.

Treatment of Actinomycosis by X-Rays, With a Report of Nine Cases. Cecil P. G. Wakeley, F.R.C.S., Arch. Radiol. & Electroth., 37: 129-135, Oct., 1923.

ACTINOMYCOSIS is not a rare disease in the London district, whatever may be said of other districts of England. During the last three years eleven cases have been presented for treatment at King's College Hospital. Two cases were those of patients too ill for any treatment. The other nine cases were treated by x-rays combined with other methods.

Though the clinical signs are fairly evident in a case of actinomycosis there are at times fatal delays in diagnosis and treatment. The thoracic variety of the disease is often diagnosed as phthisis. By the time granules are detected in the sputum the case is usually too far advanced for cure.

Treatment should consist of combined methods, as it is hopeless to treat the disease by any one method. X-ray treatment is a useful adjunct and should be started early in the disease. Radium has not been used very much in England for actinomycosis, though a few workers have reported successful treatment with it.

Actinomycosis. Herbert A. Bruce, F.R.C.S., Ann. Surg., 78:294-299, August, 1923.

TREATMENT for this disease is both local and general, the former differing with the location of the disease. "In the cervico-facial type total excision is desirable and is usually possible. Along with excision cauterization of the tissue should be employed. The x-ray and radium have been used in the early stages of the cervico-facial type with varying success." These latter agents are not mentioned in connection with any other location of this lesion.

An Anatomical and X-Ray Study of the Optic Canal in Cases of Optic Nerve Involvement. Leon E. White, M.D., Boston M. & S. J., 189: 741-748, Nov., 1923.

THE OSSEOUS canals normally afford great protection to their neural contents, but when these canals become narrowed and the sheath of the nerve or the nerve itself becomes swollen the bony walls may cause sufficient constriction to produce atrophy. It is important to film the optic canal to determine the adjacent pathology, but this is not an easy thing to accomplish and is impossible at times. The author says that the important thing to discover is the size and shape of the optic canal and it is possible to do this.

The position for filming the optic canal is given according to Macmillan: "The position in which a patient is placed for a radiograph of the optic canal is of extreme importance, as a slight variation in the position would so change the outline of the canal as to render its measurements worthless. Holding a dry skull in the hand and looking at the optic canal through the orbital cavity it is evident that the true shape and size can be seen only when the axis of the optic canal goes through the lower outer quadrant of the bony rim of the orbit. The optic canal in the living can be thrown into this area when the patient is lying face down with the malar bone, nose and lower jaw touching the plate the central ray directed straight down. If the upper rim of the orbit is allowed to touch the plate the optic canal will be thrown too high in the bony frame of the orbit and will be distorted. The diameter of an optic canal of 5 mm. would be enlarged about one-half a millimeter in the radiograph of a living subject."

As to the size of the normal optic canal the author says it is practically 5.5 mm. in diameter and varies from 3.5 to 6.5 mm. "Extensive prenumatization about the canal usually is associated with narrowing. When the lesser wing above the canal is more extensively pneumatized than other regions, the canal is flattened on top. If the region beneath the canal is also pneumatized it becomes oval, while in the rather rare instances where the bridge formed by the lateral root of the lesser wing of the sphenoid is also pneumatized, it assumes a somewhat triangular shape. Any irregularity in the contour of the canal * * * produces a diminution in its caliber, and renders its contents more susceptible to infections from the sinuses surrounding it. It seemed a fairly constant rule that the smaller the canal the more extensive the pneumatization. It should also be emphasized that small canals may be round, even though surrounded by pneumatic sinuses, so that the shape, while not all important, usually indicates

susceptibility to infection. The films of the canals many times are misinterpreted due to faulty position. The image of the canal should always appear in the lower outer quadrant of the orbit."

Radiographic Localization of Spinal Lesions by Sicard's Method. Percy Sargent, F.R.C.S., British M. J., 2:174, August, 1923.

DURING a recent visit to Paris the author saw Professor Sicard demonstrate his method of localizing certain spinal lesions by radiography after injecting an opaque fluid into the spinal theca. The method provides a new means of diagnosis and is as follows: Between one and two c.c. of lipiodol (heavy oily fluid, 40 per cent iodine and remarkably opaque to x-rays) is injected into the spinal theca through suboccipital puncture, patient sitting erect. The lipiodol is arrested at any point of occlusion of the spinal theca, and the upper limit a tumor can be easily and accurately demonstrated by x-ray examination. The lower limit of the tumor can be shown by injecting the lipiodol through a lumbar puncture and taking a radiogram with the patient in head-down position.

The author reports three cases which show the undoubted value of the method. Not only does it show whether block exists, but the exact position of the lesion with relation to the bones can be demonstrated. Localization is more accurate than that by neurological examination.

Roentgen Ray Stereoscopy. Roy Kegerreis, Physicist, Mayo Clinic. Arch. Radiol. & Electroth., 28: 105-110, September, 1923.

VISION with two eyes enables us to see things in three dimensions and the brain by co-ordinating these two groups of sensations enables us to see things as a unit of three dimensions or in stereo. As long as we look at familiar things no sensible effort is required, but in roentgen ray work one looks at the familiar in an unfamiliar way, the roentgen ray localizes objects as well as places them in perspective, hence the benefit from stereo-views.

When the eye looks at an object the laws of perspective come into play and the parts nearest the observer are most clearly outlined and appear larger, the more remote parts are foreshortened and dimmer. In the roentgenogram the parts nearest the tube are blurred and magnified the most and those nearest the screen are the clearest and magnified the least. This is an unalterable defect in roentgen ray work and must be clearly recognized. It is due to the finite size of the target.

To get stereo views two pictures of the subject are taken, and the tube is moved about six centimeters between exposures. The plates should be so marked that they can be placed in the holder in the proper manner, else pseudo-stereo views will be obtained. However, this is not of such great practical importance, since the anatomy of the human body is so well known. The stereo effect is enhanced if vivid contrasts are effected, hence the tube is moved perpendicular to the ribs when stereo views of the chest are taken. Good judgment in selecting the relative position of the part to be rayed and the direction of the tube shift can only be gained by experience. Schemes have been perfected for viewing in stereo by means of fluoroscopy, but the mechanical complications are such that although the effects are attainable and very good the practice is not apt to become common.

As an individual's two eyes seldom are just alike the strain of stereo vision may be somewhwat diminished by varying the brightness of the screen toward which one of the eyes is looking.

Elevation of the Diaphragm. Unilateral Phrenic Paralysis. A Radiological Study with Special Reference to the Differential Diagnosis. J. M. Woodburn Morison, M.B., C.M., Arch. Radiol. & Electroth., 28:111-117, September, 1923.

CONCLUSIONS: "Petit's eventratio *diaphragmatica* and unilateral phrenic paralysis are not so common as is generally supposed. Radiographically they present similar features. There is evidence, in a study of the cases presented and in the literature, that Petit's eventration may be due to: (a) a developmental defect in the muscular tissue of the diaphragm. (b) An injury to the phrenic nerve at birth. At first these conditions formed a purely pathological study; it is now possible with the advancement of radiology, to observe and diagnose such cases clinically. Many of these cases have exhibited gastric symptoms, and I would draw special attention to the deformity of the stomach due to mechanical causes which I have described. It should be noted that this deformity may become a condition requiring surgical interference. The diagnosis from a radiological standpoint rests mainly on: (a) The unbroken line extending high up into the thorax with its reversed movements, unless adhesions have formed. (b) The level of the free fluid in the stomach is that of the cardiac orifice. (c) The bismuth meal examination."

Radiological Treatment of Chronic Tonsillitis. Elis Berven, M.D., Acta Radiologica, 2:301-353, September, 1923.

THIS is a very comprehensive treatment of the subject given in an address delivered in Stockholm last June at the Congress of the Northern Association for Medical Radiology. The history of the radiotherapy of this condition, the technique of treatment, the immediate and the end-results are detailed.

The author's summary reads as herein given: "The material comprises 154 patients, 150 of whom have been treated with radium and four with roentgen rays. The application on the palatine tonsils has been done with a tong-like instrument which admits of minute focusing on the area of treatment as well as of secure fixation. The application on the pharyngeal tonsil has been done by means of an arrangement which well protects the soft palate and at the same time brings the radium preparation into direct contact with the surface to be treated. Distance treatment has been given by means of the apparatus of Dr. Lysholm (illustrated in original paper).

"Very large firm fibrous tonsils of grown people have been treated with a dosage of about 96 mg. radium element for ten to twelve hours. The total filtration power corresponds to the filtration power of 2 mm. lead. Distance equals four to five millimeters. Large soft tonsils of grown people and children have been treated with a dosage of 96 mg. radium element for two and one-half to three hours with a filter of 0.35 mm. gold plus 0.30 platinum, corresponding to a filtration power of 1 mm. lead; distance 1 mm. Small tonsils have been treated with a dosage of about 75 mg. radium element for three hours by the same technique as just given. The pharyngeal tonsil has been treated with a dosage of 50 to 96 mg. radium element for three hours with a filter of 0.35 mm. gold plus 0.30 mm. platinum and distance 1 mm. By the application of these dosages a comparatively powerful superficial effect is produced by the soft gamma radiation and the secondary beta radiation, at the same time as a deep effect is obtained by the hard gamma rays. The distance treatment has been given from the outside with three to four gr. hours at a distance of 5 cm. and with a total lead filter of 3 mm. Each tonsil has, as a rule, received one treatment at an interval of four to five weeks between the treatments of the tonsils.

"The roentgen treatment has been given in agreement, in the main, with the technique of Witherbee.

"The radium treatment has given the following results: (a) The greatly enlarged tonsils have decreased to normal or smaller size, also firm fibrous and cicatrized tonsils have reacted by a distinct diminution in size. The fissured surface has become smoother and the deep crypts shallower. The contents of the crypts have diminished or disappeared. (b) The attacks of angina, from which the patients have suffered frequently before the treatment, have ceased and the general condition of the patients has been improved. This latter fact applies especially to children. (c) The secondary symptoms which appear in connection with the local symptoms have as a rule been greatly improved, when the secondary symptoms have not been distinctly chronic. (d) the results of treatment have been, so far, permanent. (e) Out of radium treated patients, 135 have been relieved of their local symptoms; two have improved considerably; three still have throat troubles to the same extent as before; three who have only had partial treatment still have the same throat troubles; seven have abandoned treatment.

"Out of four patients treated with roentgen rays one has become symptomless, two very much improved, and one has abandoned treatment. A post-examination of 150 patients who have had x-ray treatment for tuberculous lymphoma has shown that the frequency of the angina has been unusually low in these patients after the treatment.

"By the radium treatment a temporary change appears in the blood picture, corresponding to Siegel's blood reaction of the first degree.

"The microscopic examination shows that the diminution in size is due to a degeneration of lymphocytes and to an involution of the secondary follicles.

"The radium treatment brings on processes which clinically and anatomically resemble those through which the normal physiological involution of lymphoid tissue takes place.

"The radium treatment given by the prescribed technique has not caused any injuries."

Some Results of Radium Treatment in Sarcoma. W. H. B. Aikins, M.D., Canad. M. J., 13:654-656, Cept., 1923.

IN DEEPLY seated growths the author uses gamma rays of radium. He uses flat, heavily screened applicators over the mass and varies the intensity of the dose in proportion to the extent and location of the lesion. In superficial cases he uses beta rays and prefers tubes and flat applicators to needles.

He reports that he has not had encouraging results with lymphosarcoma, but has met with success in lymphogranuloma. Treatment of ostosarcoma has been unsatisfactory and melanosarcoma is the most unsatisfactory lesion treated in this series, although radium, the author thinks, holds this disease in check at times. Angiosarcoma has yielded the most satisfactory results, as has sarcoma of the conjunctiva.

Results of Deep Roentgen Treatment of Gastro-intestinal Malignancies. William A. Evans, M.D., *and* T. Leucutia, M.D., Am. J. Roentgenol., 10:793-801, Oct., 1923.

THE AUTHORS believe that deep x-ray therapy, either in combination with surgery or alone is indicated in all malignancies of the gastro-intestinal tract. Palliative results are secured in a great number of cases, controlling many unpleasant symptoms and checking the extension of the disease in some cases.

In early cases the disease may be eradicated, especially in combination with surgery, although sufficient time has not elapsed in the authors' cases to judge of percentage of recurrences.

Careful measurement of dosage is necessary and one single massive dose must not be considered a "killing dose." Treatment should be repeated in from six to twelve weeks. The lesion must be exactly located if at all possible, and the preparation of the patient and careful postradiative treatment are factors in success.

Normal tissues must be protected, especially the lungs, suprarenal bodies and the bowel mucosa.

Restoration of the Normal Auricular Rhythm After X-ray Treatment. Carl Schwenson, M.D., Acta Radiologica, 2:430-433, September, 1923.

THE AUTHOR reports a case of a patient suffering from combined auricular fibrillation and Graves' disease. The patient was treated by x-ray. Treatment was followed at first by a pronounced hyperthyroidism which afterwards ceased to be apparent and the patient gained in weight and improved generally. At the same time the auricular fibrillation vanished and auricular action became normal. It is interesting that the electrocardiograms showed undeniable signs of a right-sided preponderance while the auricles were fibrillating, but when they had returned to normal action the normal balance between the right and left side had also been restored.

A Case of Tuberculosis of the Symphysis Pubis. J. B. Jackson, M.D., Am. J. Roentgenol., 10: 806-809, Oct., 1923.

THIS RARE condition was discovered during a search for the origin of a cold abscess in an 11 year old girl, whose parents had brought her to the author on account of a swelling upon the anterior surface of the thigh and because of a peculiar gait. The author reports the case principally for the purpose of drawing attention to such a possibility in searching for the origin of a cold abscess or fistula.

Results With Modern Radiotherapy in Bladder Tumors. Charles Goosmann, M.D., Am. J. Roentgenol., 10:804-806, Oct., 1923.

THE AUTHOR believes that all cases of papillomata of the bladder are potentially malignant and cites other writers who support this view. He reports fifteen cases. Three of these were failures, but had had roentgen treatment (no radium) before reporting to the author. Three others had had a preliminary suprapubic cystotomy. One of these three was successfully treated, the tumors being cauterized through the bladder opening. The other two were failures, one had had radium needles imbedded in the tumor and one had had radium tubes inserted in the bladder. The other nine yielded eight successful results. They all were treated by high voltage roentgen rays combined with radium. Three had fulguration treatment after radiotherapy.

Roentgen Therapy of Chronic Prostatic Hypertrophy. I. Thompson Stevens, M.D., Am. J. Roentgenal., 10:811-814, Oct., 1923.

THE AUTHOR reports two cases. In one, striking success was met, in the other no relief followed and surgery was resorted to and revealed a prostate in which several cysts were present, filled with a thick greenish material. Fibrosis was very well marked.

In proper hands the treatment is said to be without danger, and should radiation therapy fail surgery can still be resorted to. He would try radiation treatment first for the following reasons: No loss of voluntary control of bladder, rectum uninjured, no persistent urinary fistula, no shock, hemorrhage, uremia, bronchitis, septicemia, pulmonary embolism, etc., and no death has so far been encountered due to such treatment.

Treatment of Gonococcal Infection by Diathermy. E. P. Cumberbatch, M.R.C.P., *and* C. A. Robinson, M.B., British M. J., 2:54-56, July 14, 1923.

THIS PAPER reports the treatment by diathermy of 67 cases of epi-

didymitis and orchitis, cervicitis, urethritis and prostatitis. The work recounted covers a period from 1913 to the present time. Results were striking in those cases where treatment was applied to the parts originally infected. Technique is given and case histories related.

Carcinoma of the Bladder. J. B. Deaver, M.D., *and* William H. MacKinney, M.D., Ann. Surg., 78:254-259, August, 1923.

PRACTICALLY all tumors of the bladder are malignant and only two-thirds of the 131 cases encountered in the authors' practice since 1910 have been seen early enough to justify treatment.

The authors advocate cystoscopic fulguration for small or medium sized pedunculated carcinomas if uncomplicated by cystitis. Fulguration has but little place in the treatment of semi-solid, sessile papillomas and has no place at all in advanced papillary tumors or in infiltrating or squamous-cell carcinoma.

If resection of the bladder with the tumor attached can be accomplished without transplantation of the ureters the authors prefer to do this, otherwise they would use the cautery for excision of the tumor or would destroy it by the high frequency current. Radium is not advised, as they believe that it has so far "accomplished little in the cure of carcinoma of the bladder."

Tumors of the Pituitary Gland. Joseph T. McKinney, M.D., Am. J. Roentgenol., 10:835-840, October, 1923.

EARLY diagnosis of hypophyseal lesions can be made with far greater accuracy than was formerly the case and the results from operative treatment are so encouraging that many more cases are sent to the roentgenologist than used to be. The roentgenologist who regards himself as something more than a technician will make himself familiar with some of the evidences of symptomatology, clinical history and physical findings in disturbances of the pituitary gland. These are briefly sketched in the article.

If no constitutional disorder shows itself and if the findings of the central nervous system are negative then ocular changes and the roentgen ray appearance of the sella offer the best aids to diagnosis. The ocular changes are discussed.

The roentgen findings of pituitary tumors are divided into four groups: (1) No enlargement of the sella, nor erosion of the base or clinoid processes, that is, no roentgen findings. (2) Enlargement of the sella without its erosion or destruction. (3) Enlargement of the sella with thinning of the base and floor and erosin of the clinoid processes. (4) Complete destruction of sella.

There is a wide variation in the size and character of the sella even in normal individuals and the roentgenologist must be cognizant of this factor. Adenoma with cystic development is the most frequently found tumor. Neither roentgen ray findings nor ocular findings will definitely establish the extent of the lesion, this can be arrived at only by operation. Enfield insists that no roentgen ray diagnosis of pituitary tumor should be made unless there is marked erosion or positive evidence of bony changes in the sella. Dandy's methods should be useful in diagnosing this lesion. The author believes that sodium iodid solution might be used in some way to outline the tumor shadow.

End-Results in Malignant Disease of the Testis. William B. Coley, M.D., Ann. Surg., 78:370-386, September, 1923.

SURGICAL removal of the testis for malignancy gives only a comparatively small number of cures, not more than five to ten per cent. The author does not believe that radical removal of the retroperitoneal glands by the abdominal route increases that percentage sufficiently to justify the operation. Instead of radical removal he advocates long continued (at least six months) systemic treatment with mixed toxins of erysipelas and bacillus prodigiosus, combined with thorough radium or x-ray radiation of the abdomen and the supraclavicular glands. Three cases are reported cured by this form of treatment. The effect of radium will be only temporary if one waits until all other means have failed.

Diathermy in High Blood Pressure and Other Conditions. F. Howard Humphris, F.R.C.P., Brit. M. J., 2:314-318, August 25, 1923.

PATIENTS with high arterial tension may be treated by diathermy and kept in a state of safety thereby. If the hyperpiesia be recognized early, diathermic treatment will prevent an otherwise inevitable consequence. Even though arterio-sclerosis has become established the process may be stayed and the very serious sequelae avoided.

The effects are two-fold—one is general or constitutional, affecting metabolism, and the other is a local effect upon the vasomotor system. Clinically there ensues a general improvement in the health and the mental outlook, while chemically there results an increase of solids in the urine and in the perspiration. All these effects are perhaps due to the relaxation of the arteries and the better circulation resulting therefrom.

The use of medical diathermy in pneumonia has been proved of value and attention is called to this work in the United States Marine Hospital, which the author says has the best medical service of any country he has visited.

He also believes that medical diathermy is destined to play an important role in the treatment of pulmonary tuberculosis.

In the discussion of this paper Dr. Turrell said that the mode of action of diathermy and how it might apply to the case in hand should always be considered in arriving at a decision as to treatment; for example, in a case of spasmodic dysmenorrhea would relaxation of the spasm relieve the patient and would diathermy accomplish this? In an unresolved pneumonia would an increased blood supply help and would diathermy bring this about? He added that diathermy had been found of great benefit in non-surgical hemorrhoids, in dysmenorrhea and in coccygodynia of the simple congested type. It is useful, he said, for high blood pressure, but a hot bath is of equal value and is more simple treatment whenever possible. It is useful in rheumatoid arthritis, but must be long continued. All discussants agreed upon its usefulness in relief of gonococcic infections.

Treatment of Gonorrheal Affection by Diathermy. C. A. Robinson, M.B., D.M.R.E., Brit. M. J., 2:312-314, August 25, 1923.

THE GONOCOCCUS is less resistant to rises of temperature when in culture than are most pathogenic organisms, though the temperature most suited to its growth in living tissues is not known. Whether the destruction of the germs by diathermy is due to direct or indirect effects of the current the author does not know, but he is sure of the results in gonorrheal infections of the joints, namely, that such cases are amenable to treatment by diathermy. The optimum temperature to secure these effects by diathermy is about 115 degrees F. Results in cervicitis prostatitis, epididymitis, etc., have been very gratifying.

Diathermy for Malignant Disease of the Mouth, Pharynx and Nose. Norman Patterson, M.B., Ch.B., British M. J., 2:56-57, July 14, 1923.

SEVENTEEN case reports are given, most of the patients are now well from two to three years following diathermy.

Every practitioner should be alive to the possibility of malignancy in an ulcer or an indurated area in the tongue, mouth or pharynx when occurring in a patient past middle age. Such lesions are almost always malignant and are too often diagnosed as "septic sore," "cyst," "gumma." It must be remembered here that buccal or pharyngeal cancer often gives a positive Wassermann. The author prefers diathermy for the removal of the primary lesion, but if the glands cannot be dealt with surgically there is little to hope for by destruction of the primary tumor except palliation. If the diathermized area approaches or invades the facial planes of the neck then a clear interval of a fortnight or three weeks should be allowed between the time of destruction of the primary growth by diathermy and the time of the neck operation.

Treatment of Cutaneous Tuberculosis. J. H. Sequeira, M.D., F.R.C.P., F.R.C.S., British M. J., 2:503-505, Sept. 22, 1923.

THE AUTHOR'S conclusions are these: (1) We must carefully distinguish between the local application of concentrated light to lesions and the light bath. (2) The best results in lupus vulgaris are obtained by a combination of local and general treatment. The local treatment is carried out by the application of concentrated actinic light to the lesions. The light bath is the exposure of the nude body and limbs to the rays of a large arc lamp. (3) The best illuminant is a large carbon arc working at 50 amperes. The spectrum of such an arc more nearly approaches that of the sun than that of any other lamp. The carbon arc must not be inclosed; an envelope of any kind cuts off some portion of the rays. (4) The amount of pigmentation is an index of the reaction of the body to radiation. * * * So far as we know at present it is only an index. (5) As a general rule the more a patient's skin becomes pigmented the better the results. (6) We feel justified in stating that 90 per cent of all cases can be cured by combining the light bath with local phototherapy. The efficacy of local treatment is intensified by the application of light to the whole surface. (7) In addition to the healing of tuberculous skin lesions, sinuses, etc., the patients increase in weight, their general health improves to a remarkable degree and their mentality is most favorably influenced. (8) It appears that in certain subjects the treatment may require repetition at intervals. (9) Apart from tuberculosis the light bath can be recommended as a general tonic."

Professor Russ, Drs. St. Clair, Thomson and J. M. Johnston all commented favorably upon the work at Finsen's Institute.

The Artificial Light Treatment of Lupus and Other Forms of Tuberculosis. Axel Reyn, Medical Superintendent of Finsen's Light Institute, Copenhagen, British M. J., 2:499-503, Sept. 22, 1923.

THE AUTHOR believes that non-operative treatment should be the principal one in cases of surgical tuberculosis, both in children and in adults. Light baths are indispensable in the non-operative treatment of such lesions. He says that the carbon arc light can fully replace sunlight and is much superior to the mercury arc light. Sanatoriums, whether at the mountain height or the seaside, should have artificial light baths at their disposal. In treating lupus vulgaris concentrated chemical light is absolutely indispensable and it is of the greatest value to combine local treatment with light baths.

Industrial Utilization of Physiotherapy. A. J. Pacini, M.D., Victor Service-Suggestions, 23:1-4, Sept., 1923.

PHYSIOTHERAPY has up until very recently been too much in the hands of unqualified persons as ignorant of pathology as of the *modus operandi* of the energies and means employed in physiotherapy. This is a changing condition and the medical profession have come to the realization that the subject is one demanding serious analysis, the better to eliminate chauvinism. It is the duty of every physician to know when physiotherapy will aid a patient just as much as it is his duty to know when operative measures are necessary.

Occasional summaries of physitherapeutic activity are to be presented in "Service-Suggestions" and this paper reports the work of the rehabilitation clinic of the Aetna Life Insurance Company as directed by Dr. Charles P. Hutchins, Syracuse, N. Y., to whom any inquiry as to technique, etc., may be sent.

The agencies used by Dr. Hutchins in the clinics at Syracuse, Albany, Buffalo and Rochester, are hydrotherapy, thermotherapy, phototherapy, actinotherapy, diathermy, galvanism, sine currents and massage. The installation of this service has proved to be of value in conserving the maximum health and efficiency of the labor force and thereby to have splendid economic value.

It is remarked by the way that "baking and massage is a stereotyped phrase that had better be eliminated from the vocabulary of scientific men. "It is indefinite and intangible and its prescription connotes a slovenly concept of physiotherapy."

Diathermy and Its Application to Pneumonia. By Harry Eaton Stewart, M.D., Attending Specialist in Physiotherapy, U. S. Marine Hospitals, N. Y.; Consultant in Physiotherapy U.S.V.B. Hospital, New Haven, Conn.; Director New Haven School of Physiotherapy; Etc., Etc. Formerly Assistant Director, Section of Physiotherapy, Office of the Surgeon General, U. S. Army, Etc. 12 mo., 204 pp., 45 illus. Cloth, $3.00. Paul B. Hoeber, Inc., New York City.

THIS LITTLE BOOK is born out of an extensive experience with this form of treatment of pneumonia in the U. S. Marine Hospital, No. 21, Staten Island, where startling results were secured and have since then been surpassed. A large number of detailed case reports are embodied in the book as witnesses to what has been accomplished.

The history of physiotherapy and the apparatus used in diathermy are given in the introduction. The first chapter gives the general technique, while the second one treats of surgical diathermy, its physics and effects, apparatus, technique, advantages and disadvantages, indications and contra indications. The third chapter gives detailed case reports of pneumonia.. The next chapter gives a summary of total case reports, giving a comparison of treated cases and controls and the details of pathology and treatment with the results secured. Chapter five treats of bronchopneumonia, and the last chapter treats of the effects of treatment on temperature, etc., extension of disease, general results and conclusions.

The book is well written, clear, to the point, and convincing.

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